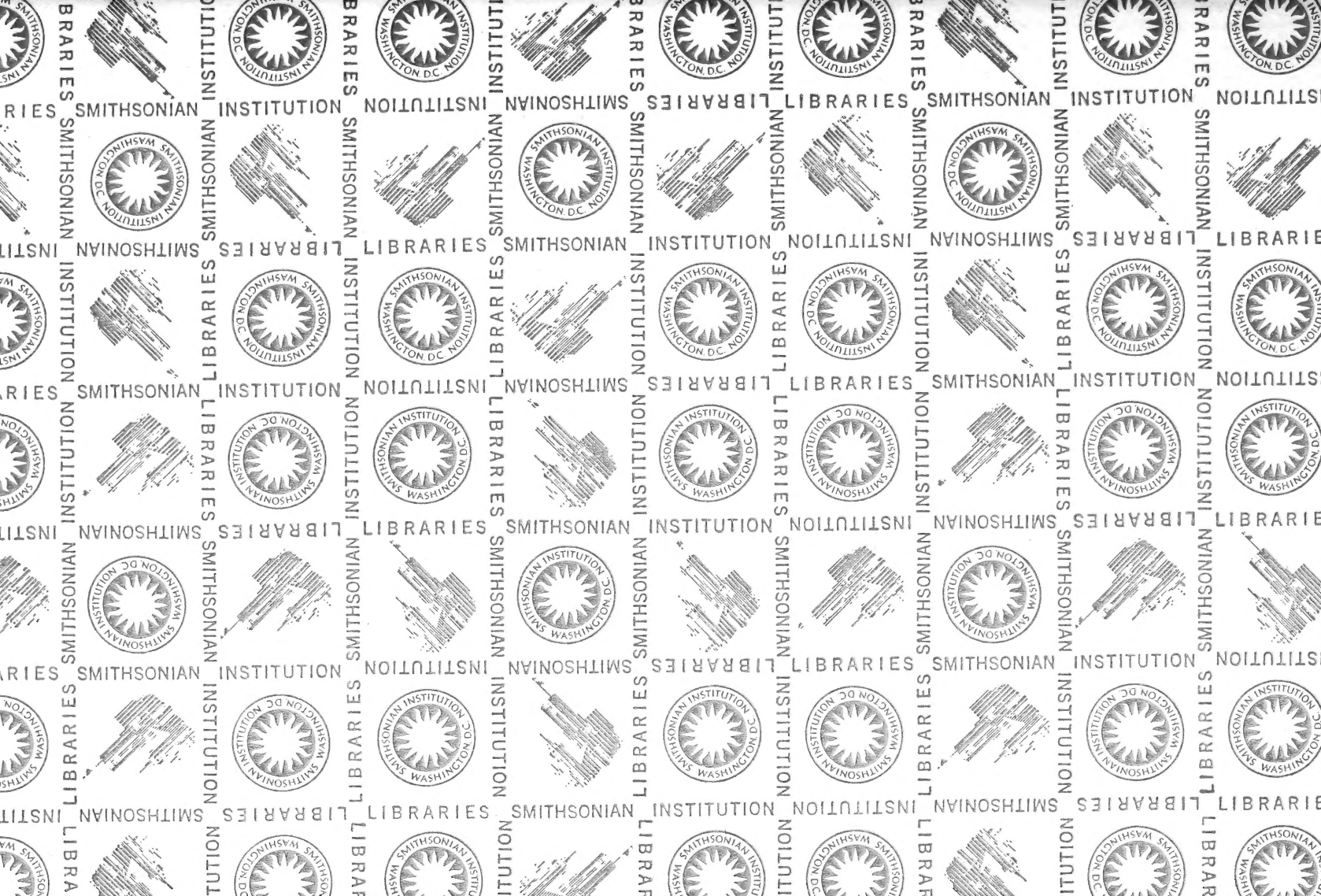
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University of the State of New York

BULLETIN

OF THE

New York State Museum

VOL. 4 No. 17

OCTOBER 1897

ROAD MATERIALS

AND

ROAD BUILDING

IN

NEW YORK

BY

FREDERICK J. H. MERRILL, PH. D.

Director New York State Museum

ALBANY

UNIVERSITY OF THE STATE OF NEW YORK

1897

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Price 15 cents

ACKNOWLEDGMENT.

The boundaries of the granite and gneiss and of the Calciferous-Trenton limestone in the vicinity of the Mohawk Valley, and the outcrops of the Niagara and Helderberg limestones are from the Preliminary Geologic map of New York prepared under the direction of James Hall, LL.D., by W J McGee.

The outcrop of the Tully limestone is from the work of S. G. Williams, 6th Annual Report, State Geologist of New York.

The Calciferous-Trenton limestone outcrops in the St. Lawrence and Champlain Valleys and in the region east of the Hudson River as well as in Ulster and Orange Counties; the areas of granite, gneiss and trap in southeastern New York, and the north boundary of the Adirondack granite and gneiss area, are from the Economic and Geologic map of New York compiled by F. J. H. Merrill.

UNIVERSITY OF THE STATE OF NEW YORK.

MAP OF THE STATE OF NEW YORK

SHOWING THE

DISTRIBUTION OF THE ROCKS MOST USEFUL FOR ROAD MATERIAL

BY

FREDERICK J. H. MERRILL

Director New York State Museum

ALBANY, N.Y.

1897.

Scale of Miles

LEGEND

Triassic	Triassic trap.
Devonian	Tully limestone.
	Helderberg limestones
Upper Silurian	Niagara limestone.
Lower Silurian	Calciferous-Trenton limestone.
Precambrian	Granite, norite and gneiss.

NOTE.

In the uncolored areas the prevailing rocks are shales, slates and sandstones except on Long Island, where sand and gravel predominate.

There are many areas of limestone too small to be shown on the map.

Within all the rock areas are local variations of quality. These must be determined by actual experience.

JULIUS BIEN & CO. LITH. N.Y.

University of the State of New York

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Elected by the regents

1888	MELVIL DEWEY, M. A., *Secretary*	Albany

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PREFACE

This bulletin was prepared at the request of the chairman of the state museum committee for a report on the road materials of New York. Having ascertained what might be worth publishing on this subject, it appeared desirable to add a short discussion on the road problem in our state.

It has been the writer's aim to make the pamphlet as brief as possible and therefore easily read. He has endeavored to discuss concisely what appeared to him the salient points of the problem, and his purpose has been rather to bring to public attention, facts not generally appreciated than to discuss matters of common knowledge.

In preparing this report the writer has communicated with about two thousand quarrymen, and has acquired much information concerning local variations in rock used as road metal, but it does not seem pertinent to this preliminary publication to discuss details which might obscure the main points. It seems also inadvisable to publish statements which discriminate between the products of various quarries until further study has established their correctness beyond all possibility of criticism. These details are therefore reserved for future publication.

The report of the special committee on good roads, transmitted to the legislature Jan. 14, 1896, is recommended to the attention of all who wish to inform themselves on the details of the present situation in New York, Massachusetts, Connecticut and other states.

Attention is also called to the publications of the Bureau of Road Inquiry of the U. S. Dept. of Agriculture.

It being impossible with the museum funds at hand to erect a laboratory for the testing of New York road materials, the writer applied for assistance to the Massachusetts Highway Commission, which courteously and generously agreed to test some representative samples of New York road material.

In the following pages the Massachusetts Commission has been quoted exclusively, not from a desire to ignore the work in other states, such as New Jersey and Connecticut, but because the problems in Massachusetts are similar to those in New York, and the Commission in question seemed to have studied and reported on the situation it had to deal with in a more detailed and exhaustive way.

To Prof. N. S. Shaler and the other Highway Commissioners of Massachusetts, the writer desires to express his deep obligations for many favors received.

FREDERICK J. H. MERRILL

Albany, Sept. 1, 1897

INTRODUCTION

Good Roads in New York

The present condition of the highways of New York is about the same as that of the roads of England at the beginning of this century, when they were so bad and the toll rates were so high that the subject of their improvement forced itself upon the attention of the British public. From the investigations which ensued under the supervision of prominent engineers, certain rules for road building were formulated, the adoption of which led to the construction of the fine highways for which Great Britain has so long been famous.

At that time there were no railroads in England and all produce was transported by wagon or canal so that the subject of road improvement was one of great commercial importance. The necessities of the occasion brought to the front in Great Britain many road engineers, most prominent among whom were Macadam and Telford, advocates of two different systems of road building, which are now used variably, according to the nature of the ground where the road is to be built. Road building under state supervision has long been a feature of European government and the time has now come when it must be recognized as a necessary function of government in the United States.

The important reasons for road improvement throughout our country are three: 1st the desirability of reducing the cost of hauling; 2nd the importance of making most of our roads fit for pleasure driving, thereby attracting to the rural districts in summer, thousands of people who create a local market for various farm products; 3rd the economic principle of preventing the great waste of labor which is now fruitlessly expended in making bad roads.

The state of Massachusetts, which in our own country leads in systematic road building, has a highly organized highway commission, which has been at work since 1894. Under the direction of this commission the important highways of the state have been measured on the new topographic map and their total length determined to be 20,500 miles, exclusive of minor cross roads. The commission has projected the construction of a network of state roads amounting to 10 % of the whole, connecting the more important points throughout the state. At

different points on this projected network the commission has constructed, by request of local authorities, short pieces of road a mile or more in length, according to the most approved methods of road building, to serve as object lessons and create by the experience of their high quality a public demand for farther construction. These short pieces are extended from year to year to carry out the general plan.

Through the courtesy of the commission I am enabled to make a statement of the appropriations and expenditures from 1894 to the present time. I quote the following from a letter written to me by Mr. A. B. Fletcher, secretary:

"In 1894 and 1895, 86.37 miles of road were laid out. These roads cost on an average, for actual construction expenses, about $9,612. per mile, and the engineering and inspection charged to them was $1,130. per mile, making a total of $10,742. the average cost of the roads per mile, exclusive of office expenses and salaries of the commission and clerks.

"In 1896 39.8 miles of road were laid out. These roads not being complete in all cases, the cost shown is to some extent an estimate. It is estimated that these roads will average about $7,900 per mile for the actual construction, and $741 for the engineering and inspection, a total of $8,641 per mile."

The appropriations for the use of the commission have been as follows:

1894	$300,000
1895	400,000
1896	600,000
1897	800,000
Total	$2,100,000

From this it will be seen that with three years of careful work, Massachusetts has built 126 miles of good road in different parts of the state to serve as object lessons to the people.

As this official statement shows, in 1896, with an appropriation of $600,000, Massachusetts constructed forty miles of high class road. Since the appropriation for 1897 is $800,000, it may be assumed that a much larger mileage will be completed. As a certain proportion of the money appropriated is used for official and clerical salaries and expenses, the whole of the appropriation is not available for road building alone, but assuming the number of miles to be constructed in 1897 at 80, it appears that the total mileage to be rebuilt (2,000) would be completed at this rate in 25 years. It will be seen that the plan of road improvement now adopted in Massachusetts, is not intended to provide for any general improvement in the 18,500 miles of public highway not included in the system to be rebuilt by the state, except through the influence of the object lessons furnished in the local examples of new state roads.

The Problem of Road Improvement in New York

It being generally conceded that better roads are a necessity in New York and there being no economical way of obtaining good roads except by building the best, the question arises as to the source of the money necessary to do this work.

High class roads, if not built by the state, can at present be afforded only in regions inhabited by persons of more wealth than the average farmer. Near the large cities are great areas tenanted by those who have business in the city, but prefer to live in the country. There the property values are much higher than in regions exclusively devoted to agricultural interests and the taxes being proportionately higher, it is possible to spend more money in road building. Under the present system of road tax prevalent over the greater part of the state, the equivalent of about $75 a mile per annum is supposed to be raised in each road district outside of the village corporation limits, and it frequently happens that the whole of the tax is not worked out. Moreover, in many districts the people work their road taxes without intelligent supervision and often not only is the labor wasted but the roads are made worse.

The state of New York having an area six times as great as that of Massachusetts, has probably six times as many miles of important roads; there being as yet no complete map of our state, it is impossible to make accurate measurement. The total mileage of important roads in New York may therefore be estimated at 123,000. This figure, while only an approximate maximum, is sufficiently accurate for purposes of estimate.

If it were decided to improve 10% of this total according to the Massachusetts plan, there would be 12,300 miles of road to build. While Massachusetts now appropriates $800,000 a year for road building, New York, if doing this work at the same rate in proportion to her size, would appropriate $4,800,000 a year. This sum would be more than one third of the total amount raised in New York by direct taxation, which is now in round numbers $12,033,651.80. This is undoubtedly too large a burden to be carried, but we could safely afford to spend from $600,000 to $1,000,000 per year in this work, which can not be avoided and must sooner or later be undertaken.

In senate bill no. 330 of 1897 introduced by Hon. Richard Higbie, it was proposed to levy 'in the general appropriation act of each year, a tax rated at one tenth of a mill upon the entire valuation of the state, which shall be known as the state highway tax.'

The total value of taxable property for the current year is stated by the comptroller to be $4,506,985,694. This sum when taxed at the rate of one tenth of a mill would yield an annual amount of $450,698.56 available for the construction of state highways. On this basis each taxpayer would contribute only 10 cents on each $1,000 of assessed valuation.

It is considered by many that the wiser method would be to divide the cost between the *state*, the *county* and the *locality benefited.*

The proportionate division suggested in senate bill no. 330 of 1897, is one half by the state and one half by the county; it being also provided that the amount paid by each county may be apportioned by the board of supervisors so that 35% of the cost shall be a general county charge and 15% a charge upon the town in which the improved highway is located, or to be assessed upon and paid by the owners of the lands benefited, according as the request for the improvement comes from the board of supervisors of the county or from the owners of one third the lineal feet frontage.

As it is to be expected that the cost of road building in New York would be about the same as in Massachusetts, viz, $10,000 per mile, the cost of rebuilding at state expense the great system of public highways mentioned above would be about $123,000,000.

If so large a sum as $4,800,000 a year were appropriated and it were found possible with this sum to build 480 miles of road per year, a period of 25.6 years must elapse before the completion of the work. On the other hand, if New York were to appropriate exactly the same amount as Massachusetts, viz, $800,000 per year and could build 80 miles per year, it would require 153.75 years to complete the system of 12,300 miles. During all of this time and for all time to come *there would remain in New York a vast network of 110,700 miles of road inadequately cared for, as at present, unless some plan for intelligent supervision and repair were provided in addition to that for the work of constructing state highways.*

The apparent difficulty of enacting legislation involving a work of such great expense and covering so long a period of time leads to the belief that the solution of the road problem in New York is to be found in the division of the expense of state road construction between the state, the county and the locality benefited as already mentioned. Even this would not be a rapid process; allowing $1,000,000 for the construction of 100 miles of road per year, 123 years would be required for the completion of the undertaking.

The foregoing statements of expense and time are not made as arguments against state roads, but to call attention to the magnitude of the project and the fact that the work must be carefully planned. It does not seem necessary that the facts should be concealed from the public in order that the work may be undertaken. It should not be assumed that the work can be started only by concealing the total cost.

The legislation hitherto proposed has chiefly aimed at a few state roads. This is insufficient. We need a trained supervision over all public roads.

In order to meet these requirements it is most important that a bureau or commission of road improvement be created by the state with, at first, a small appropriation for the practical study of the road problem in New York, and the development of plans for the building of state highways and the working of all other roads under trained supervision. If our next legislature, as all good citizens must hope, shall decide to create a commission or bureau of state highways or a superintendent of highways *the measures then enacted should provide not only for the formation of a plan to build certain state roads* which shall be models of engineering work *but for the intelligent supervision of the general repair work done on the other roads of the state* during the centuries which must elapse before our main roads are put in proper condition.

A bill was introduced into the legislature of 1897 to compel the payment of all road taxes in money. While this is a most important measure which should be made a law, it is insufficient as it provides no supervision over the manner in which the money is to be spent. According to the observation of the writer, there are large areas in New York where the people do not know how to spend their road taxes to advantage, and where the tax if actually paid in money would still be wasted, unless some trained supervision were provided by statute.

Not every civil engineer is competent to superintend road work, not every farmer is ignorant of road making; but it frequently happens that commissioners of highways have not the necessary experience and training to fit them for their office; and, serving without salary, they can not afford to give the necessary time to the road districts under their supervision. It seems indispensable that apart from and in addition to any system for the building of state highways, there should always be a corps of trained inspectors, men of experience and capacity in road building, selected solely for their qualifications and under the direction of a central bureau or commission, who would in each county, town and road district supervise the work on roads not yet being rebuilt under state super-

vision, in order that the road taxes may be economically and efficiently spent. Such inspectors must necessarily receive salaries commensurate with their qualifications. These salaries should be paid in part by the state to insure central control and the adoption of uniform standards and in part by the counties where the inspectors are stationed in order to lessen the general burden of taxation.

The League of American Wheelmen is doing much in New York to arouse public opinion in favor of good roads. It is to be hoped, however, that this influential organization will not confine its attention to state roads alone but will advocate some measure to improve the general system of road supervision and repair.

It has been suggested that a part of the excise revenue under the Raines law might be used for building roads. This practical question must be decided by the people and their representatives in the legislature.

Natural Roads

In the United States most roads have natural beds and the character of these beds is determined by the geology of the region in which they lie.

Hence the road beds consist of clay, sand, loam or gravel, or occasionally are on the surface of the country rock which may be shale, sandstone, limestone, etc.

From the fact that an unfertile soil is not good for road building, it usually happens that the poorest roads are in regions of poor farms where property values and consequently taxes are low and there is little money to spend on the roads. This is especially true in stony districts, for a stony soil is a most unmanageable material for a natural road.

Of the natural roads those on clay soil are best in dry weather, those on sand best in wet weather. When wet with a certain proportion of water, fine sand becomes hard and elastic as we see on the beaches of our Atlantic coast, where good natural roads are found near the water's edge.

Of the natural soils the best for road purposes are those variable mixtures of sand and clay called loams. Loam roads average better through the year than those of clay or sand. A limestone gravel makes a very good road, and also a fine quartz gravel mixed with clay.

From every-day experience, it is clear that natural road beds are not the best for heavy traffic when under varying conditions of moisture. It

is also clear that for many centuries to come, large areas of our country can hope for nothing better than good natural roads.

The faults of our natural roads which could easily be remedied are mainly these:

1 The roads are too narrow and too high in the center, and on account of their narrowness the wheels all run in the same track and the extreme curvature of the road bed compels the wheels to run on the edge instead of the surface of the tires, the combination of the two faults causing the formation of deep ruts;

2 Loose stones are allowed to remain in the roads and the work of repair is not directed toward keeping the surface smooth;

3 Insufficient attention is given to the construction of drains and culverts.

Road Construction

The experience of over 2,000 years has shown conclusively that there are two essential points to be aimed at in the construction of a perfect road;

1 A hard, smooth, waterproof surface;

2 A thoroughly dry foundation.

These principles were known to the Romans three hundred years before Christ and used in the construction of their best highways.

The surface of a good road must be of sufficient strength to resist the wear and tear of traffic, and smooth enough to prevent undue strain and wear on vehicles. In connection with this *the soil beneath must be made dry and kept dry*. Therefore the subject of road drainage is as important as that of road metalling.

The best road covering is composed of angular fragments of some stone which will grind on the surface into a dust, which when wet will bind or in a measure cement the fragments together, so that water will not penetrate. The angular form is essential to make the fragments interlock. The sizes should be quite uniform, except that the surface layer may consist of fragments different in size from those in the bottom course.

The total thickness of this metalling must be at least six inches on a natural soil foundation. The fragments should not exceed two and a half inches in diameter, and should be rolled in two separate courses with a heavy steam roller until the surface is absolutely firm. This is the Macadam system.

Where the soil foundation is clay, or for any reason difficult to drain, the Telford method is used. In this case a course of flat stones about six inches deep, set on edge and closely wedged together, is placed upon the soil and crushed stone is placed over this four inches thick and rolled solid. In good practice it is customary to roll the earth before the stone is laid upon it and then roll the stone foundation. The Telford foundation forms a bridge which prevents the road from sinking in moist soil and is rendered completely effective by tile drains on each side of the road. *After the road is built it must be kept constantly in repair and the neglect of this principle is to a great extent responsible for the poor roads of the United States.*

The Macadam and Telford systems above described are necessary for roads designed for heavy traffic in all weathers, but roads for pleasure driving in summer only, do not need the same expensive preparation.

As an example of the methods adopted for the construction of high class roads I am permitted by the courtesy of the Massachusetts Highway Commission to quote the following extracts from its pamphlet of *Instructions to engineers*, published in 1896:

Gravel. You will use gravel for surfacing the road bed under telford; also for surfacing the sub-grade where the natural soil is clayey, loamy, or where ordered under other conditions by the chief engineer. The gravel must be practically free from sand and clay.

Broken stone. State highways are divided as follows with reference to the broken stone (sizes given are in inches):

1 All trap rock, 1 bottom 1st course to be 1¼ to 2½; top course to be ½ to 1¼;

2 All trap rock, both courses to be 1¼ to 2½;

3 Local stone other than trap, bottom course to be 1¼ to 2½; top course to be ½ to 1¼;

4 Local stone other than trap, both courses to be ½ to 2½;

5 Bottom course of local stone other than trap, ½ to 2½; top course of trap rock, ½ to 1¼;

6 Bottom course of local stone other than trap, ½ to 2½; top course of trap rock, 1¼ to 2½;

7 All trap rock, bottom course to be ½ to 1¼; top course to be 1¼ to 2½;

8 Local stone other than trap, bottom course to be ½ to 2½; top course to be 1¼ to 2½.

When 'local stone other than trap' is used you must not allow any soft or disintegrated rock to go upon the road; all such rock must be rejected before breaking. If the contractor fails to remove such rock, immediately report the fact in writing to the chief engineer.

All broken stone must be screened, and any broken stone which will not pass through a 2½ inch ring, or is more than 2½ inches in its largest diameter, must be rebroken or rejected.

In every case the screenings used on the surface as a binder course must be of the same kind of stone as the top course of the road.

Rolling. When possible roll the sub-grade with a steam roller.

If the sub-grade is too sandy to roll, cover with coarse gravel laid on to a depth of 3 inches, or as much more as may be needed to give a good foundation.

Fill any depressions with the same material until the surface is true and even.

All broken stone must be rolled in screened layers.

After spreading the first course of broken stone, begin rolling at the sides, and continue this by running ahead so as to allow from 2 to 5 inches of the driving wheel to pass over the shoulder, and backward with the outer edge of the driving wheel from 5 to 10 inches inside the edge of the broken stone. Roll until the stone ceases to 'wave' in front of the wheels, and until it seems firm under foot as you walk over it. Next begin on the other side and roll in the same manner. Then work toward the center until the stone is rolled. Roll each layer of stone in the same manner.

If the road shows a wavy motion after passing the roller over it three, four or more times, it may indicate too much moisture in the sub-grade. If, on examination, you find this to be true, stop rolling and move ahead, allowing time for the sub-grade to dry out.

With some coarse, hard granitic rocks it has been noted that after the roller passes over them a few times they begin to 'crawl' and the sharp edges break off. A slight sprinkling of sand or stone screenings, or water, may prevent this. Try one after another of these means, until the work progresses to your satisfaction. You must not expect to prevent the stone from shaking as you walk over it, but you need to continue the rolling until the fragments of stone adjacent to where the foot presses do not move as you walk. Most of the rolling must be done before you spread the screenings. After spreading the screenings, water and roll until the mud flushes to the surface. You can not expect to prevent the stone from kicking out if the teams pass over the road. Keep watch, and in a few days have the roller pass once or twice over the road, after watering, until the loose stones are pressed down out of sight.

Before spreading any broken stone, great care must be taken to have the sub-grade carefully shaped and thoroughly compacted.

All shoulders must be shaped and left sufficiently high to roll to the proper grade, before any broken stone is spread on the road.

In case of heavy fills you must not run the roller to the edge of the shoulders unless the fill has had time to settle. Work out slowly on this kind of work.

In every case the screenings used on the surface as a binder course must be of the same material as the top course of the road.

Excepting where it may be needed to compact hard, granitic rocks, as before referred to, you will use water only on the top, or binder course.

You will wet this binder course thoroughly before rolling, but not to the extent of saturating the foundation. You will get better results and

prevent the screenings from being picked up by the wheels of the roller if you apply the water and allow it to settle down below the top surface before passing the roller over it. Too much water, or too little, will give trouble by causing the surface to be picked up.

You must not under any conditions roll the screenings while dry.

You must not under any conditions allow teams to pass over the road after the screenings are spread and before they are rolled.

In case of a deficiency in the water supply, you may have the screenings spread and await a rain before rolling; but in such case the road must be entirely closed to travel, and the rolling must be begun as soon as the road is wet and continue until the section covered with screenings is thoroughly compacted. In such cases it may be necessary to operate the roller day and night, and you must insist on this being done. In case you meet with any difficulty in compacting the stone, and fail to understand the cause, report immediately in writing to the office.

Telford. Telfording will be used in all cases where the road passes over clay, or wet soil. You will make a careful study of the road, and report in writing to the chief engineer where in your opinion telfording is needed, giving a description of the soil, together with the general scope of the adjacent ground. In your report you will note the stations between which the telfording may be needed.

Where telford is to be used, you will see that the road bed is excavated and carefully rolled, and left true and even, corresponding to the cross-section, and 12 inches below the established grade of the finished work. You will then cause 2 inches of gravel to be uniformly spread over the sub-grade. On this sub grade you will place a foundation of stones, which may vary in size as follows: 4 to 10 inches in width, 6 to 20 inches in length, 5 to 6 inches in depth (not more than 10% of the stone to be less than 6 inches in depth). The stone must be sound, and of a quality approved by the chief engineer.

The telford stones shall be placed by hand, vertically, on the broadest edges and lengthwise across the road, so as to form a close, firm pavement. They shall be bound by inserting and driving down, in all places where it is practicable, stone of proper size and shape to wedge them in their proper position. No large stone will be left with a projecting point coming nearer than 4 inches to the finished grade and cross-section. If any such projection be found, it must be broken off to allow a clear depth of 4 inches of broken stone.

The telfording shall then be rolled with a steam roller, all depressions filled with stone chips or spalls, rolled and left true and even and 4 inches below the finished grade and cross-section. If a drain is to be put in, it must be finished after the excavation is made and before the gravel is spread.

Drains. Where telfording is used, or where ground water from a side hill may work injury to the road, you will build drains.

If the road passes through a cut, you will place a drain on each side.

If the road is on a side hill, you will place a drain on the up-hill side only.

All drains must be carried to a proper outlet, either to a culvert, to another drain or through the bank.

Where it is necessary to extend a drain to an outlet beyond the section needed to be drained, you will lay the pipe with cement joints on such extension, and omit the gravel or stone in the trench.

Where a pipe is carried through a bank, the outlet must be protected by masonry, as provided in pipe culverts.

All pipe must be laid true to the line and grade, and no pipe is to be laid on a grade of less than 3 inches in 100 feet.

If in laying out a drain you find the trench is likely to exceed 5 feet in depth below the finished grade, you will immediately report the conditions in writing to the chief engineer.

The center of the pipe in all drains will be placed 12 inches outside of the line of broken stone.

When the grade of the finished road is 3 inches or more to the 100 feet, the bottom of the drain trench must be 3½ feet below the finished surface of the road at that part of the cross-section.

The drain trench will be excavated to a width of 12 inches at the bottom and 15 inches at the top, and should be excavated only as fast as the drain can be finished.

On the bottom of this trench you will place 2 inches of gravel or broken stone which will pass through a 1¼ inch mesh and not through a half-inch mesh.

All side drain pipe will be 5 inches salt-glazed vitrified clay pipe, with bell and spigot joint (unless stated to the contrary in the specification).

The pipe is to be laid on the grade hereinbefore mentioned, with open joints and the bell end toward the rising grade.

Gravel or broken stone of the sizes already described will be filled about the pipe and over it for a depth of 5 feet. This must be carefully tamped about and rammed over the pipe. The remainder of the trench is to be filled with stone which will pass through a 3 inch and not through a 1 inch mesh. Great care must be taken to prevent any sand, silt or earth from getting into the pipe or the interstices of the stone in the trench.

The sub-grade of the road is to have a regular slope to the edge of the drain.

Gutters. Paved gutters will be built where directed by the chief engineer.

No gutter is to be laid until after the broken stone has been rolled.

In no case is the roller to pass over any part of any paved gutter.

Gutters not exceeding 400 feet in length shall be 3 feet wide with a shoulder 1 foot wide and a dish of 3 inches.

Gutters exceeding 400 feet in length shall increase the dish above this length at the rate of 1 inch to each 300 feet.

All stone used in gutters shall be rounded field, bank or river stone; no flat, shaky or rotten stone shall be used.

The stone may on the average lay from 4 to 6 square yards to the ton. A cubic yard may be estimated to weigh 1⅓ tons.

The larger selected stone will be laid in the gutter itself and on the edges to a true line and grade, with the largest diameters lengthwise of the road. All other stone will be laid with the longest diameters across the gutter.

The trench shall be excavated to a depth of 12 inches below the finished grade of the gutter; gravel shall then be spread and rammed to a depth of 4 inches. A layer of bedding sand or gravel free from stone larger than ½ inch in diameter shall then be spread of a sufficient thickness to bring the gutter stones which are bedded in it to the proper grade and cross-section after they are thoroughly rammed.

Each stone is to be rammed to an unyielding foundation. The surface shall then be covered with sand or screened gravel, which must be well broomed into all joints. The stone shall then be re-rammed and the surface left true and even. Sand or screened gravel shall then be spread over the entire surface of sufficient depth to fill all interstices.

The edge of the gutter toward the road shall be left ¼ inch below the surface of the adjoining broken stone; in no case must it project above it.

Any broken stone which may be disturbed during the paving of the gutter must be carefully replaced and thoroughly rammed.

The bank on the outside of the gutter must be sloped to the gutter, so as to have no bunches or depressions on its surface.

These extracts show the careful attention paid to small details of construction, in the state highway work of Massachusetts.

Earth Roads, Construction and Maintenance

It is not proposed, within the limits of this article, to go into further detail on the subject of road building, as there are already many books in which this subject is adequately treated, especially the construction of Macadam and Telford roads. It seems important however, to call attention to some of the difficulties encountered in maintaining earth roads. If there were no rainfall it would be comparatively easy to make and maintain roads of clay, loam or gravel. Rain, snow and frost are the chief sources of trouble. *Theoretically* by a curved cross-section of road bed the water is caused to flow off, *practically* as soon as the road bed is softened by rain, wheel tracks quickly form longitudinally and prevent the water from escaping except at long intervals. It therefore is of little value to give an earth road a cross-section of pronounced curvature. The nearer flat it is without approaching concavity the wider the bearing of the wheels on the road bed and the less the cutting by them. A slight convexity is desirable to balance the wear along the central line.

In hilly districts where grades are steep, it is of the greatest importance to prevent the water from flowing lengthwise of the road. This is effected inexpensively by making a ridge of earth across the road which turns the water to one side or the other. These ridges, which are called breaks or breakers and in some localities 'thank you ma'ams,' are uncomfortable to drive over and have little durability. On very steep ascents

these breaks are of use in supporting heavily laden wagons while the teams are resting.

The practice of chaining a wheel in descending a steep hill with a loaded wagon, which method provides an inexpensive substitute for a brake, rapidly wears deep ruts in hill roads and in the 'breakers' built across them. This practice is far more destructive than the use of narrow tires and should be prohibited by law as soon as possible. On hill roads where the ascent is not too steep to permit the maximum load to be drawn continuously so that it is not necessary for the team to stop and rest, a very satisfactory substitute for 'breakers' is found in a wooden box drain or sluice placed across the road at a slight angle with the perpendicular, the top consisting of oak slats about 3 in. x 4 in. with a space of about 2 in. between them. These transverse gratings intercept and carry off the water flowing lengthwise of the road, which if allowed to go far would gain in volume and erosive power until serious damage would be done.

A part of the work of the Massachusetts Highway Commission has been to eliminate steep grades from the roads built at state expense. In many cases a change of location has been found necessary to accomplish this end.

A serious cause of wear on roads is the filling of the gutters with snow and ice which often accumulates to such a height as to make the center of the road the principal line of drainage. When this occurs on earth roads, in early spring a large volume of snow-water follows this channel, seriously damaging the road and necessitating much expense in its repair. Even the best type of Macadam or Telford road would eventually be damaged in this way. I am informed by the Massachusetts Highway Commission that it has been found necessary in that State to have the snow removed from the gutters in order to prevent damage of this character. When the gutters are open it is not a difficult matter to remove the snow and ice if sufficient money is provided for the purpose. It is however, the custom in our rural districts to have gutter bridges and box or stone drains at the junction of private roads or minor cross roads with the main highways. When these become clogged with ice as they invariably do, it is impossible to clear them without taking them apart and this is rarely practicable.

In Massachusetts these gutter bridges are prohibited on the new roads, the lateral roads being made to meet the main roads at a very gentle slope, leaving an open gutter which may be driven over without discomfort. With an earth road it would be difficult to maintain such an open

gutter at road intersections unless some person were detailed to keep it in continuous repair. As this has not yet been found practicable on public roads, the gutter bridge is everywhere in use, and in the spring it is a fruitful source of injury to the road. It will be seen from every day observation and from the details stated above that the earth road while as yet all that the people have agreed to have in New York has necessarily many elements of self-destruction and can never be regarded as permanent. The development of the wheel scraper or road machine has made it possible however to keep an earth road in good condition if intelligently used.

For speedways and pleasure driving in general, a well kept earth road in dry weather is superior to all others. The perfect Macadam or Telford road is too hard to permit of very fast driving without injury to the feet of horses.

Road Materials and their Distribution

In New York the best materials for road metal are trap, granite and magnesian limestone.

Trap is a general term for some of the basic eruptive rocks, the word being related to or derived from the German *Treppen* which signifies a flight of steps and is suggested by the somewhat regular manner in which the rock is jointed.

The trap which is used in New York for a road metal is a diabase and consists chiefly of the minerals augite and labradorite, the former being a silicate of iron and magnesia and the latter being a lime-soda feldspar. Other minerals are present in small quantity but do not influence the properties which make the rock valuable as a road metal.

While sufficiently hard to resist the wear of heavy traffic to a satisfactory extent it possesses a high degree of binding or cementing power. This means that the dust produced by wear when moistened unites quite firmly and forms a cement which binds the larger fragments to a considerable extent.

This property is most noticeable in rocks containing much lime, magnesia and alumina.

Good trap is known only in Richmond and Rockland counties, and in the intermediate area of New Jersey bordering the Hudson river. Its very prominent outcrop is known as the ' Palisades.'

Granite consists chiefly of quartz mixed with one or more of the feldspars and hornblende or a mica. Hornblende has essentially the same composition as augite which occurs in trap; and a hornblende granite should be a

very good road metal. Where hornblende is absent one would expect to find less binding power.

Granite is harder than trap and therefore should resist wear better, but this quality is offset by its usually smaller binding power due to the presence of quartz so that trap should be preferred as a rule.

Granite is found in the Adirondack region and in the Highlands of the Hudson, also in Westchester county. The commercial term granite includes various kinds of gneiss.

Magnesian limestone has great binding power but is quite soft and therefore not very durable for heavy traffic. Chemically, this rock is chiefly a carbonate of lime also containing carbonate of magnesia, alumina and silica. Limestone entirely free from magnesia is rare.

It has been suggested that this stone may be used profitably as a binder over stone of less binding power.

Limestone is found chiefly in areas parallel to and near the main line of the New York Central railroad and in a zone around the Adirondacks.

Sandstone consists chiefly of quartz, has usually no lime, magnesia or alumina and therefore has no binding properties and never makes a first rate road, as the fragments continually break loose.

In New York the best road materials occur in certain limited areas, and at points distant from these the cost of transportation is the controlling feature in the question of their use.

The accompanying map shows the distribution of the areas of rock already mentioned which are available for road construction in New York.

For high class road building, trap and granite will be preferred and used in all places where their cost is not prohibitory. Experience shows, however, that unless these materials are used under the direction of experienced road engineers, they are less satisfactory than limestone, and when it is proposed to macadamize a road by simply covering it with broken stone, the latter though less durable, will be more satisfactory.

When granite and trap are properly laid, on a well prepared bed and rolled with a heavy steam roller to the proper standard of firmness, nothing can be better, but where no steam roller is available and the subgrade is not properly prepared, the trap and granite are liable to afford only an unpleasant and uneven surface of hard angular fragments which ceaselessly roll about on the surface of the road injuring the horses and making pleasure driving impossible.

Limestone from its softness and greater binding power is more easily rolled into an even surface under the wheels of vehicles, and while not

having the durability to support heavy traffic for a long time, can be cheaply renewed if the source of supply is not far distant. This fact has been recognized for a long time at points within easy reach of the limestone quarries. In Onondaga county at many points a portable crusher has been used to crush for road metal the blocks from the limestone fences which are cheerfully donated by the residents for the improvement of the roads. There are many other counties in which this might be done as may be seen from the map which shows the distribution of the limestone areas. In most of these areas limestone will be found in the fences and may be crushed for road metal at small expense.

The lists of quarrymen and the maps at the end of this bulletin explain the distribution of materials available for road building.

The distribution of road materials may also be studied in greater detail on the Economic Map of New York by F. J. H. Merrill which shows both the geology and the mineral deposits on a scale of 12 miles to 1 inch and on the Preliminary Geologic Map of New York by the State Geologist which shows the geology on a scale of 5 miles to 1 inch.‡

In addition to the outcrops and ledges where quarries may be opened the deposits of boulders and gravel whrch we call glacial drift often yield good materials for road metal at a long distance from the original source. These deposits cannot as yet be mapped but they are usually well known in the regions where they occur.

Tests of Road Material

The most practical test of road metal is actual use, and this has been the principal guide in the past; but as the demand becomes greater for new localities of road metal in order to reduce transportation charges, it has become necessary to devise physical tests which may be used in the examination of new materials offered for road building.

The following description quoted from the report of the Massachusetts Highway Commission for 1896, describes in detail the methods in use by that organization.* †

LABORATORY EXPERIMENTS ON ROADBUILDING STONES

The following described results were obtained in the highway laboratory of the engineering department of the Lawrence Scientific School of Harvard University. Those under the head 'Coefficient of abrasion' were obtained by the Deval method, which has been employed for some time by the French engineers for determining the relative value of the

* Pp. 86–91. † In this quotation, metric weights and measures have been reduced to common forms.

‡ For Westchester Co. see A Geological Map of a Part of Southeastern New York by F. J. H. Merrill, in Bulletin 15, N. Y. State Museum; also in 48th Ann. Rept. N. Y. State Museum.

stone used in the construction and maintenance of the national highways of France. These results are said to agree well with those obtained in actual practice.

The apparatus used in the tests consists of a cast-iron cylinder 8 in. in diameter and 13.6 in. in depth. At one end is an opening which can be closed with a tightly fitting iron cover. This cylinder is mounted on an axle at an angle of 30° with the axis of the cylinder, and is supported on an iron frame. At one end of the axle is a pulley wheel by which the cylinder is revolved; at the other is an instrument which records its revolution.

The stone to be tested is first broken into pieces, between 2½ in. and 1¼ in. in diameter, which are carefully washed, to remove any foreign matter. In the cylinder are placed 5 kilograms (13⅓ lbs) of this stone. The top is then bolted on, and the cylinder is made to revolve for 5 hours at the rate of 2,000 revolutions an hour, making in all 10,000 revolutions. By this process the stones are thrown from one end of the cylinder to the other, and at the same time are rolled against the sides of the vessel and against one another. When 10,000 revolutions are completed, the cover is removed, and the contents emptied into a tray. The cylinder is then thoroughly washed, to remove the dust that adheres to its sides. Each stone above 1¼ in. in diameter is then washed under the same water. This water is then filtered, and the filtrate when dry is mixed with the detritus taken from the cylinder. The detritus is then put into a sieve, by which it is separated automatically into seven sizes. These seven sizes, together with the stones that have not been worn below 3.18 cm. in diameter, are each carefully weighed, and their weights recorded.

The amount of detrition under 1-16 in. is rarely less than 20 grams per kilogram of stone used (2 %), therefore 20 has been adopted as the standard, and the coefficient of quality is obtained by the following formula:

$$q = 20 \times \frac{20}{u} = \frac{400}{u} \qquad u = \text{per cent}$$

in which u represents the weight in grams (15.43 grs.) of detritus per kilogram (2 2-3 lbs) of stone.

It seemed well, in beginning this work, to be guided as far as possible by the experience of others, and for this reason the Deval test was adopted, for it appeared to be the only practical method of testing road metals yet devised. After a number of trials were completed with the Deval apparatus, and their results studied, it was recognized that all the valuable properties possessed by a good road metal were not embraced in this test. The value of any good stone as a road metal is due to certain properties possessed by it. Among these there are three which stand prominent — cementing value, toughness and hardness. It is evident that the Deval apparatus does not test the very important property of cementing value in the different road metals. The commission, recognizing this deficiency, accordingly directed its attention to devising some means of supplying it. As no previous attempt has been made in this direction, the commission had to invent its own method, which is as follows:

The stone to be tested is ground to a powder, and passed through a sieve of 100 meshes to 1 in. The powder is then put in a slightly tap-

ered steel die of circular section, about 1 ¼ in. diameter, mixed with water, and subjected to a pressure of 2,300 kilograms (about 3 tons). The resulting briquette is then put aside for at least one week, so that it may thoroughly dry.

It was at first thought that a test by direct compression would determine the cementing power of the stone. A number of briquettes were tried in this way, but the results were not very satisfactory. On further consideration, it appears that a test by impact would more thoroughly determine the cementing power of the stone then that by compression, and this method would have the further advantage of approximating more closely to the actual conditions obtaining on roads; accordingly a machine was devised for testing the briquettes by impact. With this machine a hammer one kilogram (2 2-3 lbs) in weight can be dropped freely from any desired height upon a plunger under which the briquette to be tested is placed. The hammer works automatically and is tripped at the desired height. Attached to the plunger is a lever, pivoted at one sixth of its length from the plunger, and carrying a pencil at its free end. The pencil has a vertical movement five times as great as that of the plunger, and its movement is registered on a drum against which the pencil presses. The drum rotates through a small angle at each stroke of the hammer. An automatic diagram is thus taken of the behavior of the briquette throughout the whole test.

An analysis of the diagram so taken shows at once the number of blows required to cause the destruction of the briquette. A very interesting point is brought out by these diagrams, viz, in every case the diagram shows that the plunger rebounded at each stroke until the briquette began to fail. This behavior is exactly analogous to the elastic phenomena observed in all material of construction; consequently the point at which the briquette ceases to rebound corresponds to the elastic limit of the material. Beyond this point the briquette falls to pieces rapidly.

Briquettes were made from many kinds of stone, and were tested in this machine. It was thought desirable to use a constant blow for all the briquettes, and a short experience indicated a fall of 1 ¼ in. as suitable, since it broke the most tenacious materials with a moderate number of blows, and yet was not too great to permit the careful determination of the properties of the poorer stones. All the briquettes were 1 in. high.

The surface of a macadamized road is constantly being abraded and recemented. Evidently a road made from a material which has the property of recementing in a high degree will keep in better condition than one made from a material of lower recementing power. It was therefore desirable to determine the recementing properties of the stones tested. A new set of briquettes was made, differing from the former only in that they were of constant weight instead of constant height. These were tested in the manner described above, and then were remade and retested.

It has not been thought desirable to present herewith the complete data obtained from the impact test: as the series is not yet completed. The writer has, however, collected and shown in the accompanying table some of the more important results thus far obtained, a sufficient number to indicate the scope of the work done. In this table the stones are arranged in the order of their power of resisting abrasion. Column 1

contains the specific density of the stones; column 2, the coefficients of abrasion (determined in the manner previously described); the next column gives the number of blows required to stress the 1 in. briquettes to their elastic limits; column 4 gives the same data for the first testing of the 30 gram (463 gr.) briquettes prepared for the recementation test, and the next column gives the number of blows that the recemented briquettes will stand before reaching their elastic limits."

Through the courtesy of the commission six specimens of typical New York rocks were subjected to the abrasion test with results which are noted in the following table; which also gives the results of some tests of Massachusetts rocks.

Table showing specific densities, coefficients, cementing values and recementing values of stones tested

NAME OF STONE	City or town	1 Specific density	2 Coefficient of wear	3 Cementing value	4 Cementing value of 30 gram briquette	5 Recementing value of 30 gram briquette
**Massachusetts rocks*						
Diabase	Lynn, Essex co., Mass	3 03	20 37	.....	56	29
Felsite	Boston, Suffolk co., Mass	.....	16 06	23	109	31
Hornblende granitite	Duxbury, Plymouth	2 68	13 46	.....	.....	.....
" "	Waltham, Middlesex co., Mass	2 62	12 16	16	.....	.....
Gneiss	Lee, Berkshire co., Mass	.....	11 43	23	.....	.....
Limestone	Pittsfield, Berkshire co., Mass	2 82	9 38	15	.....	.....
Quartzite	Diamond Hill, Cumberland, R. I.	.....	9 07	9	.....	.....
Marble	Lee, Berkshire co., Mass	2 74	2 85	.....	.....	.....
†New York rocks						
Diabase, Bouker	Guttenberg, N. J.	.....	30 40	.....	.....	.....
" Conklin & Foss	Rockland Lake, N. Y	.....	17 79	.....	.....	.....
Norite	Cortland, Westchester co	.....	7 46	.....	.....	.....
Granite, D. Donovan	Round Island, Rockland co	.....	23 02	.....	.....	.....
Silicious sandstone	Lockport, Niagara co	.....	17 48	.....	.....	.....
Sandstone	Duanesburg, Schenectady co	.....	10 53	.....	.....	.....
Limestone	Howes Cave, Schoharie co	.....	9 64	.....	.....	.....
"	Tomkins Cove, Rockland co	.....	6 31	.....	.....	.....

* From the Report of the Mass. Highway Com. 1896. † Tests made for the New York State Museum by the Mass. High. Com.

As shown by the preceding table, the New York rocks tested in the laboratory of the Massachusetts Highway Commission were only subjected to the abrasion test and therefore the results can not be fully compared with the tests of the Massachusetts rocks which are given above. Two samples of traps were tested, one from the Bouker quarry at Guttenburg and one from the quarry of Conklin & Foss at Rockland Lake. The specimen tested from the Bouker quarry proved to be very much harder than that from the Conklin & Foss quarry. There are two varieties of trap found in the Bouker quarry; one being considered of inferior quality and known by the quarrymen as "*false trap.*" It is part of the lower portion of the trap mass and being near the sandstone which forms its lower foundation, it cooled more rapidly and assumed a finer texture and a harder condition than the mass above. Although this so-called false trap has not been subjected to a cementation test, one would expect it to prove equally valuable with the rest in this respect, as its chemical composition is probably nearly identical with that of the softer trap immediately adjoining. It was a sample of the "false trap" which was tested.

It is stated that where used at some points on Long Island it has proven unsatisfactory, the fragments not holding together and forming an even surface, but frequently flying out.

The attention of the writer has been called to this fact, but he has not sufficient information to warrant a full expression of opinion. The difficulty may be due to improper construction in building the road. It might also be due to the mixture of this harder variety of trap and softer material from the same quarry, it being well established by experience that unless the road-metal in the surface layer is of uniform hardness, it will not wear uniformly. To establish the truth in this case would involve a good deal of experimental work for which no funds are available, but theorizing on the facts accessible, there seems no reason why the harder trap or false trap should not make a good road provided it is kept separate from material of different hardness and is laid under the supervision of a competent engineer.

As a rule when it is not possible to make numerous tests and experiments, it will be cheaper to use those materials which have proven satisfactory in actual use.

Owing to the press of state work it was not possible for the Massachusetts commission to make cementation tests of the specimens submitted. The tests made, confirm the results of practical experience and show that granite, trap and sandstone are harder and offer more resistance to abrasion than the limestones. The cementation test, when made, would unquestionably show the highest cementing value to be in the limestone, trap and granite and the lowest in the sandstone.

Producers of road-metal in New York state

Limestone

P. C. denotes that the stone is crushed in a public crusher owned or hired by the town or village. The number in the column headed *test* is the coefficient of abrasion as determined in the laboratory of the Massachusetts Highway Com.

NAME	Test	Town or village	County	
Allter Bros.	.....	St Johnsville	Montgomery	
Alvord, A. E.	.....	Manlius	Onondaga	
Babcock, Dwight	.....	Waterloo	Seneca	
Barber Asphalt Paving Co	.....	Buffalo	Erie	
Behan's Estate, James	.....	Manlius	Onondaga	
Bennett, J. & Son	.....	Auburn	Cayuga	P. C.
Britton & Clark	.....	Onondaga	Onondaga	
Brown & Fleming	.....	Verplanck	Westchester	
Buffalo Cement Co	.....	Buffalo	Erie	
Callanan Road Imp. Co	.....	South Bethlehem	Albany	
Chaumont Co. (The)	.....	Chaumont	Jefferson	
Chazy Marble Lime Co	.....	Chazy	Clinton	
Conley, F. E	.....	Oriskany	Oneida	
Driscoll Bros. & Co	.....	Ithaca	Tompkins	
Dunlap & Co., R	.....	Jamesville	Onondaga	P. C.
Foery & Kastner	.....	Rochester	Monroe	
Hibbard, John P.	.....	East Onondaga	Onondaga	
Howard, John F	.....	Ogdensburg	St Lawrence	P. C.
Howe's Cave Association	4.15	Howe's Cave	Schoharie	
Hudson River Stone Supply Co	.....	Stoneco	Dutchess	
Jones, Hadley	.....	Littlefalls	Herkimer	
Lauer & Hagaman	.....	Rochester	Monroe	
Lynde, B. A.	.....	Bellevue	Erie	
Miller, Geo. W. & D. C.	.....	Newburgh	Orange	
Mohawk Valley Stone Co	.....	Palatine Bridge	Montgomery	
Newark Lime & Cement Mfg. Co.	.....	Rondout	Ulster	
Ransier, Huestis B	.....	Manlius	Onondaga	
Roberts, R. W.	.....	Collinsville	Lewis	P. C.
Shute & Rightmyer	.....	Hudson	Columbia	
Smith, W. T.	.....	Sharon Springs	Schoharie	
Snyder, C. G.	.....	Aquetuck	Albany	
Solvay Process Co	.....	Onondaga	Onondaga	
Stainthorpe, C. N.	.....	Lockport	Niagara	
Tomkins Cove Stone Co	6.34	Tomkins Cove	Rockland	
Wagar, Isaac F	.....	Milton	Saratoga	
Whitmore, Rauber & Vicinus	.....	Rochester	Monroe	
Worlock, Cyrus	.....	Perryville	Madison	

Granite

Ausable Granite Co., B. B. Mason, agent	.....	Keeseville*	Essex	P. C.
Bellew & Merritt Co	.....	Tuckahoe	Westchester	
Donovan, Dan'l E	1.73	Round Island [a] town of Stony Point	Rockland	
Rampe Bros	.....	Pine Island, town of Warwick	Orange	
Smith, Hay	.....	Garrison	Putnam	
Thousand I. Granite Co	.....	Grindstone Island town of Clayton	Jefferson	

* This rock is technically a *norite*

a Near Iona Island

PRODUCERS OF ROAD-METAL, Etc., concluded.

Trap

NAME	Test	Town or village	County
Bennett, Frank	.....	Port Richmond	Richmond
Conklin & Foss	2.25	Rockland Lake	Rockland

New York firms having quarries in New Jersey

Bouker Contracting Co	1.31	Guttenberg	Hudson Co., N. J.
Carpenter Bros	.....	Guttenberg	" N. J.
Lane, John S. & Son	.....	Fort Lee	Bergen Co., N. J.

Sandstone

Albion Stone Co	.....	Albion	Orleans
Conley, F. E	.....	Higginsville	Oneida
Fowles, Joseph	.....	Ithaca	Tompkins
Shear, Albert & Co	3.80	Duanesburg	Schenectady
Swett, A. L	.....	Medina	Orleans
Whitmore, Chas	2.29	Lockport	Niagara

Directory of Quarrymen in New York State

Arranged in alphabetical order by post-office addresses

† Proprietors of quarries operating previous to 1897; now idle.
* Proprietors of quarries operating in 1897.
Parties not marked with dagger or asterisk have not been heard from directly, but are reported to be operating.
B. S. = Building stone
R. M. = Road metal
L. = Lime
C. = Cement
M. = Marble
P. C. = Public crusher

Granite

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY		
		Town or village nearest to the quarry	County	
Cold Spring	Bailey, C. W.*	Phillipstown	Putnam	B. S.
"	Bailey, James E.†	"	"	"
Garrison	Smith, Hay*	"	"	B. S. & R. M.
Gloversville	Edel, John*	Johnstown	Fulton,	B. S.
"	Wright, John	?	"	
Goshen	Empire State Granite Co.*	Pine Island	Orange	B. S.
Keeseville	Ausable Granite Co. (B. B. Mason, agt.)*	Chesterfield	Essex	B. S. & R. M., P. C.
New York	Donovan, Daniel E.*	On Round Island, town of Stony Point	Rockland	B. S. & R. M.
Montreal	Thousand I. Granite Co.†	Thurso	Jefferson	B. S. & R. M.
Peekskill	Mohegan Granite Quarrying Co*	Cortland	Westchester	B. S.
Pine Island	Rampe Bros*	Warwick	Orange	B. S. & R. M.
Suffern	Rice Bros	Ramapo	Rockland	
Thurso	Kelly Granite Co*	Clayton	Jefferson	B. S.
"	Potter, O. L†	"	"	B. S.
"	White, Burgess & Co*	"	"	B. S.
Tuckahoe	Bellew & Merritt Co*	Tuckahoe	Westchester	B. S. & R. M.

Gneiss (Granite)

Croton Falls	Ganung, Edwin C †	Carmel	Putnam	B. S.
Hartsdale	Butler, C	Hartsdale	Westchester	B. S.
"	Dobbs, G. W	"	"	B. S.
"	Hitchcock, Welcome G.	"	"	B. S.
"	Landers, J. H	"	"	B. S.
"	Wilson, J. C*	"	"	B. S.
Hastings	Nichols Henry *	Greenburg	"	B. S.
Littlefalls	Littlefalls and Dolgeville R. R.†	Littlefalls	Herkimer	R. M.
Scarsdale	Seely, Henry S †	"	"	B. S.
Tarrytown	Sackett, Stephen J. (estate)*	"	"	B. S.

Trap

Haverstraw	Conklin & Foss *	Rockland Lake	Rockland	R. M.
Port Richmond	Bennett, Frank*	Northfield	Richmond	R. M.

New Jersey quarries supplying New York

Guttenberg, N. J	Lane, John S. & Son *	Guttenberg	Hudson	R. M.
New York city	Bonker Contracting Co*	"	"	R. M.
Port Chester, N. Y	Carpenter Bros *	Fort Lee	Bergen	R. M.

Limestone

Accord	Bennett, John*	Rochester	Ulster	B. S.
"	Krom, George*	"	"	L.
"	Longendyke, A. N.	"	"	
"	Rose, W. H	"	"	
"	Wakeman, J.*	"	"	B. S.
Akron	Akron Cement Co.*	Newstead	Erie	C.
"	Newman, H. L. & W. C.*	"	"	B. S., C.
Albany	Callanan Road Imp. Co.*	South Bethlehem	Albany	R. M.
Albion	Staines, Thomas F.*	Barre	Orleans	L.
Amsterdam	Hewitt, D. C.*	Amsterdam	Montgomery	B. S., L.
"	Vanderveer, T. B.*	"	"	B. S., L.
Aquetuck	Snyder, Carl*	Coeymans	Albany	R. M.
Auburn	Bennett, J. & Son*	Auburn	Cayuga	B. S., R. M., P. C.
"	Goodrich, L. S. & Son	"	"	B. S.
Batavia	Berthum, August	Batavia	Genesee	
"	Merrill, John*	"	"	B. S., L.
Bigelow	Williams, Charles & Co.*	De Kalb	St Lawrence	L.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — LIME-STONE — (*Continued*)

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY	
		Town or village nearest to the quarry	County
Boonville	Lee, Albert J.*	Boonville	Oneida B. S., L.
Brasie Corners	Fleming, Walter	Macomb	St Lawrence L.
"	Hall, R. G.	"	" L., B. S.
Bellevue	Lynde, B. A.*	Bellevue	Erie R. M.
Brooklyn	Flynn, P. H.*	Saugerties	Ulster B. S.
Buffalo	Ambrose, E. J.	Buffalo	Erie
"	Armbruster, Joseph*	"	" B. S.
"	Barber Asphalt Paving Co.*	"	" R. M.
"	Buffalo Cement Co. (lim.)*	"	" R. M. & C.
"	Consumer's Lime Co.	Clarence	" B. S.
"	Cumming's Cement Co.	Newstead	" C.
"	Cutter & Bailey*	Buffalo	" B. S.
"	Fogelsanger, D. R. & H.	Amherst	" B. S.
"	Gehres, Anna*	Buffalo	" B. S.
"	German Rock Asphalt Co.	Lockport	Niagara
"	Gesl, John Jr.	Buffalo	Erie B. S.
"	Grattan & Jennings	"	"
"	Kabel, Martin*	"	" B. S.
"	Kehr, A. P.*	Clarence	" B. S.
"	Straub, Peter G.	"	" L.
Burlington, Vt.	Burlington Mfg. Co.†	Port Henry	Essex M.
Canajoharie	Allen, William	Canajoharie	Montgomery L.
"	Rapp, G.	"	" B. S.
"	Shaper, A. E. & D. C.	"	" B. S.
Canandaigua	McNulty, Frank*	Canandaigua	Ontario B. S.
Canton	Stevens, E. E.	Canton	St Lawrence M.
Catskill	Palmer, H. P.*	Catskill	Greene L.
Cazenovia	Burr, J. T.	Fenner	Madison
Chaumont	Adams & Dufort	Chaumont	Jefferson
"	Chaumont Company	Lyme	" B. S., R. M., L.

Chazy	Chazy Marble-Lime Co.*	Chazy	Clinton B. S., R. M., L.
"	Goss, L. M.	"	" L.
Cherry Valley	Bastian, William	Cherry Valley	Otsego L.
"	Eldridge, O. H.†	"	" L.
Chittenango Falls	Keeler, Charles	Fenner	Madison L. & C.
"	Tooke, D. J.*	"	" B. S.
"	Winchell, W. M.	"	"
Clayton	Denney, Leander*	Clayton	Jefferson B. S.
Climax	Haswell, D. G.	Coxsackie	Greene
Cobleskill	Baard, Frank*	Cobleskill	Schoharie L.
"	Brandenstein, John*	"	" B. S.
"	Reilly, William*	"	" B. S.
Collinsville	Jones, Hugh D.	West Turin	Lewis L.
"	Potter, M. N.	" "	"
"	Roberts, R. W.*	" "	" R. M., L.
"	Whittlesey, Walter	" "	"
"	Williams, B. B.	" "	" L.
Columbia	Manning, A.	Columbia	Herkimer
Coxsackie	Day, Ambrose	Coxsackie	Greene L.
Cranberry Creek	Kegg, Willard	Northampton	Fulton L.
"	Warren, Willis E.	?	"
Crary Mills	Church, Ashley	Potsdam	St Lawrence L.
Dolgeville	Dolge, Alfred*	Oppenheim	Fulton B. S.
Dover Plains	Bensen, Geo. V.	Dover	Dutchess
East Onondaga	Hibbard, John P.*	Onondaga	Onondaga B. S. & R. M.
East Pitcairn	Van Patten, F. A.*	Pitcairn	St Lawrence L.
Ellenville	Van Dermark, B.	Wawarsing	Ulster L.
Fayetteville	Bangs & Gaynor*	Manlius	Onondaga C.
"	Ransier, Huestis B.*	"	" B. S. & R. M.
"	Sheedy, Thomas W.	"	" C.
Fort Edward	Harris, John F.*	Whitehall	Washington B. S.
Franklin Iron Works	Juhl, M.*	Augusta	Oneida B. S.
Glens Falls	Glens Falls Co.*	Queensbury	Warren L., B. S., M.
"	Jointa Lime Co.*	"	" L., B. S.
"	Morgan Lime Co.*	Moreau	Saratoga L.
"	Reynolds & Riordan*	Queensbury	Warren B. S.
"	Sherman Lime Co.	"	" L.
Gloversville	Mayfield Lime Co	Mayfield	Fulton L.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — LIMESTONE — (*Continued*)

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY	
		Town or village nearest to the quarry	County
Gouverneur	Abbott, J. B	Gouverneur	St Lawrence L.
"	Empire Marble Co.*	"	" M.
"	Gouverneur Marble Co.*	"	" M. B. S.
"	Northern New York Marble Co.*	"	" M.
"	Potter, Charles A	Fowler	" M.
"	St Lawrence Marble Co	Gouverneur	" M.
"	Wright, H. J	Fowler	" L.
Greenwich	Bennett, H. C.*	Greenwich	Washington B. S.
Harris Hill	Fiegle, August	Clarence	Erie L.
Harrisville	Brady, Mary*	Diana	Lewis L., B. S.
Hart Lot	Carrigan, P. C	Elbridge	Onondaga
"	Heavern, Charles	"	"
"	Gorham, Aaron	"	"
"	Keenan, John	"	"
Hickory	Ingram, Vilast	Macomb	St Lawrence L.
"	Perin, Wm	"	" L.
Holland Patent	Hillidge, James G	Trenton	Oneida B. S.
Hoosick Falls	Carey, William	Hoosick	Rensselaer B. S.
"	Dolan, John*	"	" B. S.
"	McCaffrey, Cornelius*	"	" B. S.
Howe's Cave	Howe's Cave Assn.*	Cobleskill	Schoharie R. M., B. S., L. & C.
"	Howe's Cave Lime & Cement Co.*	"	" B. S. L. & C.
Hudson	Shute & Rightmyer	Jonesburg & Hudson	Columbia B. S., R. M.
Ingham Mills	Butler, Sherman	Manheim	Herkimer
Ithaca	Driscoll Bros. & Co.*	Ithaca	Tompkins B. S. & R. M.
Jamesville	Alvord, E. B. & Co.*	Dewitt & Lafayette	Onondaga B. S., L. & C.
"	Dunlap, R. & Co.*	Dewitt	" R. M. & C., P. C.
Johnson	House, Samuel*	Johnson	Orange L.
Jonesburg	Jones, Fred W.*	Greenport	Columbia B. S. & M.

Joy	Horn, William	Sodus	Wayne
Kattsbaan	Fiero, William*	Saugerties	Ulster L.
"	Valk & Beers*	"	L. & B. S.
Kerhonkson	Gordon, E. H	Rochester	" L.
Kingston	Noone, Luke†	Kingston	Ulster B. S.
LeRoy	Heinlich, John	LeRoy	Genesee L.
"	Holmes, George H.*	"	" B. S.
"	Howell, Livingston H.*	"	" B. S.
"	Morris & Strobel	"	" B. S.
"	Paugrazio Bros.*	"	" B. S.
Leyden	Auer, Melchior*	Leyden	Lewis B. S.
Lincoln	Gould, T. O	Walworth ?	Wayne
"	Hanson, William	"	"
Littlefalls	Jones, Hadley*	Manheim	Herkimer B. S. & R. M.
Lockport	Heary, M. F	Lockport	Niagara B. S.
"	Levalley, W. B	"	"
"	Lockner, William E.*	"	" B. S.
"	Lockport Stone Co.*	"	" B. S.
"	Stainthorpe, C. N. & Co	"	" B. S., R. M.
"	Tuohey, P. H.*	"	" B. S.
"	Upson, W. H	"	"
"	Watson, T. G.*	"	" B. S.
"	Whitmore, Charles*	"	" B. S.
"	Wilson, John H *	"	" B. S.
"	Woodward & Son	"	"
Lowville	Babcock, William L	Lowville	Lewis B. S.
"	Carter, L. H	"	" B. S.
"	Gowdy, Hiram*	"	" B. S.
"	Lyman, M. M.*	"	" B. S.
"	Waters, John M	"	" B. S. & L.
Lyon's Falls	Post, Orville	West Turin	"
Manlius	Behan, James, estate of*	Manlius	Onondaga B.S. & R. M., L. & C.
"	Brown Cement Co	"	"
Marcellus	Malley, William*	Marcellus	" B. S. & L.
Marcellus Falls	Walker, Laura E	"	" C.
Mayfield	Warner, S. B	Mayfield	Fulton L.
Mettacahonts	Gray, Stephen	Rochester	Ulster L.
Middle Falls	Bates, H. B.*	Greenwich	Washington B. S. & L.
"	Cipperly, John	"	Washington

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — LIMESTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY		
		Town or village nearest to the quarry	County	
Middle Falls	Grouty, James M	Greenwich	Washington	B. S.
"	Kenyon, Ambrose	"	"	
"	Sullivan, Patrick	"	"	
Middleville	Mosher, W. W.*	Newport	Herkimer	B. S.
Mill Grove	Shoff, B. O.*	Mill Grove	Erie	L.
Mohawk	Humphrey, J. W.*	Columbia	Herkimer	L.
Munnsville	Adams, Frank*	Stockbridge	Madison	B. S.
"	Palmiter, Amos*	"	"	B. S. & L.
Natural Bridge	Ashcraft, F. E.*	Diana	Lewis	L.
"	Hall, E. & W.*	Wilna	Jefferson	L.
Newark, N. J.	Anderson & Moynehan*	Newcomb	Essex	L.
Newburgh	Brown, David*	Newburgh	Orange	B. S. & L.
"	Miller, Geo. W. & D. C.	"	"	L. R. M.
Newcomb	Sayre, James R. jr. & Co*	Kingston	Ulster	B. S., L.
Newport	Higgins, Gilbert	Newport?	Herkimer	
"	Morey, Newell	"	"	
"	O'Connor, George H.*	"	"	B. S.
"	Sherman, John	"	"	
"	Toumey Daniel	"	"	
New York	Duryee Portland Cement Co	Montezuma	Cayuga	C.
"	Newark & Rosendale Lime & Cement Co.*	Whiteport	Ulster	L. & C.
"	O'Connell & Hillery	Tuckahoe	Westchester	L.
"	Snowflake Marble Co.*	Pleasantville	"	M. & L.
Niagara Falls	Messing, Bernard	Niagara	Niagara	L.
"	O'Rourke, Michael	"	"	
North Litchfield	Davies, Albert R.	Litchfield	Herkimer	L.
"	Dickson, Charles	"	"	L.
"	Holland, George E.*	"	"	L.
"	Salisbury, John E.*	"	"	L.

North Western	Vale, John D	Western	Oneida L.
"	Van Dyke, John H.*	"	" B. S.
Norwood	Hale, George W.*	Potsdam	St Lawrence B. S.
"	Murray, James L.	" ?	"
Ogdensburg	Howard, John F.*	Oswegatchie	St Lawrence R. M., B. S. & L.
"	Nevin, John H.	"	" B. S.
Onondaga Castle	Kelly Bros.	Onondaga	Onondaga B. S.
" "	McElroy & Sons	Onondaga	Onondaga
" "	Storrier Bros *	"	" B. S.
Oriskany Falls	Putnam estate	Augusta ?	Oneida
Palatine Bridge	Mohawk Valley Stone Co*	Palatine	Montgomery B. S. & R. M.
Perryville	Hodge, Mrs. F. W	Sullivan	Madison
Pittsburgh "	Worlock, Cyrus*	"	" L. & C. R. M.
Phelps	Edson, B.	Phelps	Ontario
"	Johnson, William H	"	" B. S.
Pine Island	Brown, B. T.	Warwick	Orange L.
" " Pittsburgh	Elston, Charles †	"	" L.
Plattsburg	Behan, Hugh	Plattsburg	Clinton B. S.
"	Pray, G. W	Peru	" L.
"	Robinson, Thomas	Plattsburg	" B. S.
Pleasant Valley	Russell, Everit †	Pleasant Valley	Dutchess L.
Pleasantville Station	Cornell Lime Co *	Mount Pleasant	Westchester M. & L.
Prospect	Talcott, Charles L.	Russia	Herkimer L.
"	Thomas, Evan T *	Trenton	Oneida B. S.
Poughkeepsie	Bain, F. R.	Dover ?	Dutchess B. S.
"	Hufcut, H. D	"	"
"	Lawlor, Michael	"	"
Ravena	Day, Abraham	Coeymans	Albany
"	DeFriest, W. V. D. H *	"	" B. S.
"	Hotaling, David.	"	" B. S.
"	Hughes, William *	"	" B. S.
"	McCullock, Conrad	"	" B. S.
Rochester	Foery & Kastner*	Rochester	Monroe R. M. & B. S.
"	Lauer & Hagaman *	"	" R. M. & B. S.
"	Nellis, J. B. (administrator)†	"	" B. S. & L.
"	Neuman, R. G.*	Gates	" L.
"	Smith, B. P.*	Union Springs	Cayuga B. S.
"	Whitmore, Rauber & Vicinus*	Rochester	Monroe B. S. & R. M.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE LIMESTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY	
		Town or village nearest to the quarry	County
Rondout	Gross, F. W.	Kingston	Ulster B. S.
"	Lawrence Cement Co.*	"	" C.
"	Newark L. & C. Mfg. Co.*	"	" R. M. L. & C.
"	New York & Rosendale Cement Co.*	Rosendale	" C.
Rossie	O'Brien, John*	Rossie	St Lawrence L.
Sandy Hill	Drake & Stratton Co. (limited)†	Queensbury	Warren B. S.
"	Monty, Higley & Co.*	Kingsbury	Washington B. S.
"	Sturtevant, D.	South Glens Falls	Saratoga B. S.
Saratoga Springs	Slade, Charles G.*	Greenfield	" B. S.
"	Wagar, Isaac F.*	Milton	" B. S.
"	Wing, Prince; estate	"	" L.
Sauquoit	Thurston, W. W.	Paris	Oneida
Schoharie	Becker, Clinton L.	Schoharie	Schoharie B. S.
"	Brown, Albert*	"	" B.S.,R.M.& C.,P.C.
Seneca Falls	Fisher, John	Fayette	Seneca B. S. & L.
Sharon Springs	Mallett, F. C	Sharon	Schoharie
"	Smith, Henry S.*	"	" L.
"	Smith, Jefferson†	"	" B. S.
"	Smith, W. T.*	"	" B. S. & R. M.
Shelby	Simonds, E. B.†	Shelby	Orleans L.
Sing Sing	Ossining Lime Co.*	Ossining	Westchester L.
Skaneateles Falls	Starr, Levi	Sennet	Cayuga B. S.
Smith's Basin	Keenan Lime Co.*	Kingsbury	Washington L.
"	Nichols, D. & Son	Hartford	" L.
Smith's Landing	Gould, J. H.*	Catskill	Greene B. S.
"	Massino, William	"	" B. S.
Sodus Center	Mather, E. B. & Co.*	Sodus	Wayne L.
"	Munn, Gardner A.*	"	" L.
South Greenfield	Wing, Elihu	Milton	Saratoga L.
Split Rock	Connors, James	Onondaga	Onondaga B. S.

Split Rock	Crowley, Cornelius*	Onondaga	Onondaga B. S.
Springfield Center	McDonough, William*	Springfield	Otsego B. S.
St. Johnsville	Allter, Bros.*	St Johnsville	Montgomery B. S., R. M.
"	Fitzer, C.*	"	" B. S
"	Hilligar, Chas.	"	"
"	Fox, D.	"	"
"	Nagle, Thomas.	"	"
"	Place, Daniel	"	"
"	Smith, Albert A.	"	"
"	Smith, W. C.*	"	" L.
Stoneco	Hudson R. Stone Supply Co.	"	" B. S.
Stone Ridge	Basten, John*	Stoneco	Dutchess R. M.
"	Davenport, Solomon*	Marbletown	Ulster B. S. & L.
Syracuse	Alvord, A. E.	"	" L.
"	Britton & Clark	Manlius	Onondaga L., C., R. M.
"	Hughes Bros.*	Onondaga	" L. & R. M.
"	Thomas, C.*	"	" B. S.
"	Solvay Process Co.*	"	" B. S.
"	Wadsworth, George*	"	" B. S. & R. M.
Three Mile Bay	Barron, John J.*	"	" B. S.
Thurman	Pelletier, John	Lyme	Jefferson B. S.
Ticonderoga	Joubert, Israel*	Thurman	Warren M.
Tomkins Cove	Tomkins Cove Stone Co.	Bolton	" B. S.
Towner's	Penny, P. D.*	Tomkins Cove	Rockland R. M.
Tribe's Hill	Hurst, Henry & Son	Patterson	Putnam B. S.
"	Putman, J. G	Mohawk	Montgomery
"	Shanahan, James	"	"
Troy	Cheney, W. D. & Son	"	" B. S.
Tuckahoe	New York Quarry Co.	Smith's Basin	Washington L.
"	Norcross Bros	Eastchester	Westchester M.
"	Tuckahoe Marble Co.	"	" M.
"	Young, James S	"	" M.
Union Springs	Shalebo, J. L.	Springport	Cayuga L.
"	Wood, George P.*	Hamburg	" B. S.
Utica	Callahan, Ed.*	Trenton	Oneida B. S.
"	Conley, F. E.*	Oriskany Falls	" R. M.
Verplanck	Brown & Fleming*	Verplanck	Westchester R. M.
Walworth	Mann, Owen	Walworth	Wayne L.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — LIMESTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY	
		Town or village nearest to the quarry	County
Walworth	Read, John*	Walworth	Wayne L.
Waterloo	Babcock, Dwight*	Fayette	Seneca B. S. & R. M.
Warwick	Burt, Thomas*	Warwick	Orange B. S.
Watertown	Cory, Henry S.*	LeRay	Jefferson L., B. S.
"	Gould, A	Watertown ?	"
"	Hunting, S. E	Pamelia	" B. S.
"	Phillips, Patrick*	Watertown ?	"
"	Williams, E	" ?	"
Wawarsing	Hoornbeck, Charles*	Warwarsing	Ulster L.
West Troy	Mark, George*	Glens Falls	Warren B. S.
West Walworth	Hanson, William	Walworth	Wayne
West Winfield	Bradley, A. P.*	Winfield	Herkimer L.
Whitfield	Barley, Albert*	Rochester	Ulster L.
"	Dixon, Benjamin C.*	"	" L.
Whitehall	Adams, Terry	Whitehall	Washington
"	McLaughlin, John	"	" B. S.
Williamsville	Young, J. B. & F. H.*	Williamsville	Erie L. & B. S.
Willsboro Point	Frisbie, C. W.*	Willsboro	Essex B. S.
Wolcott	Post, Alonzo*	Butler	Wayne L.
"	Walker, Charles J.†	"	" B. S. & L.
Wolcottville	Luckman, William J.*	Royalton	Niagara L.
	Sandstone		
Albany	Fuller's Son's Wm.*	New Baltimore	Greene B. S.
Albion	DeGraff & Roberts	Barre	Orleans B. S.
"	Garrett & Atkinson	"	" B. S.
"	Goodrich & Clark Stone Co	"	" B. S.
Belfast	Lang, James†	Belfast	Allegany B. S.

Belmont	Johnson, James	Amity	Allegany	B. S.
Belvidere	Dibble, Albert	"	"	B. S.
Canajoharie	Shaper, A. E	Canajoharie	Montgomery	B. S.
Clayton	Wilber, S. H.	Clayton	Jefferson	B. S.
Cleveland, Ohio	Albion Stone Co*	Barre	Orleans	R. M., B. S.
Clinton	Dawes, Charles*	Kirkland	Oneida	B. S.
"	McCabe, John	"	"	B. S.
"	Moore, Richard	"	"	B. S.
Cooperstown	Wood, John	Middlefield	Otsego	B. S.
Corning	Bedient, James H	Corning	Steuben	B. S.
"	Kelley, John	"	"	B. S.
Dansville	Schubmehl, Martin J*	Dansville	Livingston	B. S.
Dormansville	Stewart, William	Westerlo	Albany	B. S.
East Guilford	Miller, Wm.†	Guilford	Chenango	B. S.
Elmira	Symonds, A. D	Elmira	Chemung	B. S.
Fort Ann	Holmes, Andrew D.	Fort Ann	Washington	B. S.
"	Parrish, Franklin	"	"	B. S.
"	White, Jenkins	"	"	B. S.
Fort Jackson	Downey Bros	Hopkinton	St Lawrence	B. S.
Frankfort	Joslin, M. T.*	Frankfort	Herkimer	B. S.
Fulton	Granby Brownstone Co	Granby	Oswego	B. S.
"	Jennings, Orvill J	Volney	"	B. S.
Goodyears	Barger, J. G †	Genoa	Cayuga	B. S.
Grand View	Brown, Wm. H	Orangetown	Rockland	B. S.
Hammond	Finegan, John C*	Hammond	St Lawrence	B. S., F.
"	Foster, H. A	"	"	B. S.
"	Parmeter, D. E	"	"	B. S.
"	Stanley, W. H	"	"	B. S.
Haverstraw	Demarest, P. E	Haverstraw	Rockland	B. S.
Highland	Clearwater, F. S.	Lloyd	Ulster	B. S.
Himrod	Cheney, Louis A.*	Himrod	Yates	B. S.
Hindsburg	Baldwin & Hinds	Murray	Orleans	B. S.
"	Burns, L. G	"	"	B. S.
"	Chadwick Bros	Albion	"	B. S.
"	Chadwick, Thos. Jr	Murray	"	B. S.
Holley	Downs & Bowman †	Clarendon	"	B. S., F.
"	O'Brien & Co	Murray	"	B. S.
Hornellsville	Cobb, J. F	Hornellsville	Steuben	B. S.
Hulburton	Fancher & Newsome*	Murray	Orleans	B. S., F.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — SANDSTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY		
		Town or village nearest to the quarry	County	
Hulburton	Ford A. H	Murray	Orleans	B. S.
"	Gwynne, C. F	"	"	B. S.
"	Hamilton Chas. J	"	"	B. S.
"	Hebner, John	"	"	B. S.
"	Lardner, Thomas	"	"	B. S.
"	Phillips, Marcus	"	"	B. S.
"	Squire, A. J	"	"	B. S.
"	Sturaker & Sullivan	"	"	B. S.
"	Von York, Constantin	"	"	B. S.
Ithaca	Fowles, Joseph *	Ithaca	Tompkins	R. M., B. S.
"	Mc. Clune, G. C †	"	"	B. S.
Jamestown	McVeigh, John	Ellicott	Chautauqua	B. S.
Lewiston	Hotchkiss, L. W	Lewiston	Niagara	B. S.
Lockport	Kinney, Rebecca	Lockport	"	B. S.
"	Spalding Wm	"	"	B. S.
"	Whitmore, Chas. *	"	"	R. M., B. S.
Malden	Ulster Bluestone Co *	Quarryville	Ulster	B. S. & F.
Malone	Bashaw, Levi	Malone	Franklin	B. S.
"	Morris, Antoni	"	"	B. S.
"	Paddock S. A	"	"	B. S.
Medina	Garrett, Thos	Ridgeway ?	Orleans	
"	Gorman, Chas. A *	Murray, Barre, Ridgeway	"	B. S. & F.
"	Gorman & Stork	Barre	"	B. S.
"	Gotts & Stork	"	"	B. S.
"	Horan, Patrick	Ridgeway	"	B. S.
"	Horan, Mrs. S. J	"	"	B. S.
"	Kearney & Barrett	"	"	B. S.
"	McCormick, A. J	"	"	B. S.
"	Mooney Bros.	"	"	B. S.

Medina	Noble & Lyle	Ridgeway	Orleans B. S.
"	O'Reilly, Bernard	Murray	" B. S.
"	Scanlon, Martin	Barre	" B. S.
"	Slack, Michael	Murray	" B. S.
"	Stark, Joseph	Ridgeway	" B. S.
"	Swett, A. L.*	Medina	" R. M., B. S.
"	Wall, Wm. H. Sup't Holloway Quarries†	Ridgeway	" B. S.
Middleburg	Bishop, Amberson	Middleburg	Schoharie B. S.
Monroe	Davison, John G.*	Monroe	Orange B. S. & F.
New Hudson	Searle, Mr.	New Hudson	Allegany B. S.
North Cohocton	Whitney, Theo.	Cohocton	Steuben B. S.
Nyack	Puff, Nelson	Orangetown	Rockland B. S.
"	Smith, Dan F	"	" B. S.
Olean	Olean Bluestone Co	Olean	Cattaraugus B. S.
Olive	Bogart, E. H.*	Olive	Ulster B. S. & F.
Oswego Falls	Faulkner, James	Granby	Oswego B. S.
Oxford	Burns, Edward	Oxford	Chenango
"	Clark Bluestone Co. F. G.*	"	" B. S. & F.
"	Coman, Wm.*	"	" B. S. & F.
"	Hogan & Britt	"	"
"	Johnston & Kertsner	"	"
"	Keeley Bros.	"	"
"	Oldfield, James	"	"
"	Woods, Theodore	"	"
"	Young, Richard	"	"
Penn Yan	Cornwell, Geo. R.	Milo	Yates B. S.
Portageville	Genesee Valley Bluestone Co*	Genesee Falls	Wyoming B. S.
Port Henry	Bond, L. W.	Moriah	Essex B. S.
Potsdam	Clarkson Quarries*	Potsdam	St Lawrence B. S., F.
"	Merritt & Tappan	"	" B. S.
"	Potsdam Red Sandstone Co	"	" B. S.
Rexford Flats	Benedict, Levi	Aqueduct	Schenectady B. S.
Rochester	Brady, Gilbert*	Albion	Orleans B. S.
"	Brown, Henry S.	Rochester?	Monroe
Rockville	Searl, Abram*	Belfast	Allegany B. S.
Saugerties	Burhans & Brainard*	Saugerties	Ulster B. S., F.
Schenectady	Shear, Albert & Co*	Aqueduct & Duanesburg	Schenectady R. M., B. S.
Shelby Basin	LeValley, John*	Ridgeway	Orleans B. S. & F.
South Berne	Bailey, David*	Westerlo	Albany F.

DIRECTORY OF QUARRYMEN IN NEW YORK STATE — SANDSTONE — (*Continued*).

POST-OFFICE ADDRESS	NAME	LOCATION OF QUARRY	
		Town or village nearest to the quarry	County
South Hammond	Seymour & Edgar	Hammond	St Lawrence B. S.
St Johnsville	Smith, W. C.	St Johnsville	Montgomery
Trumansburg	Biggs, D. S. & Sons.*	Ulysses	Tompkins B. S. & F.
Utica	Conley, F. E.*	Higginsville	Oneida R. M. & B. S.
Warsaw	Warsaw Bluestone Co	Rock Glen	Wyoming B. S.
Washington Mills	Griffiths, Wm	New Hartford	Oneida B. S.
"	Mallory, J. P	"	" B. S.
"	Thompson, E. F	"	" B. S.
"	Trimbey, H. J.*	"	" B. S.
Watkins	Higgins, D. H.*	Dix	Schuyler B. S.
Watts Flats	Gould Fred H.*	Harmony	Chautauqua B. S.
Waverly	Boget, M. L.*	Barton	Tioga B. S.
"	Fleckenstine, J. W.	"	"
"	Murray, John H	"	"
Whitehall	McLaughlin, John	Whitehall	Washington B. S.

Bluestone

Bluestone is a variety of sandstone, which, by reason of its even texture can be cut or sawed into any desired form and is therefore peculiarly available for house trimmings of various kinds. In general, the layers in the quarries vary from an inch to several feet in thickness; the thinner of these are used for flag stones and the thicker are cut into dimension stone for building purposes.

The bluestone industry is chiefly located in Ulster county and the quarries are almost innumerable but the business is controlled by a few large dealers who are located at points favorably situated for shipment and who, to a considerable extent, buy stone from the men who quarry it. Bluestone is also produced in the counties of Albany, Greene, Sullivan, Delaware and Chenango in Eastern New York and in Cattaraugus and Wyoming counties in Western New York.

The geological horizon of the commercial bluestone is very near the dividing line between the Hamilton and Portage groups. It is, however, not usually possible to determine in which of these groups a given quarry belongs owing to the great scarcity of fossils.

* PRODUCERS OF BLUESTONE

POST OFFICE ADDRESS	NAME	Town or village nearest to the quarry	
	Albany county		
Reidsville	Otto Bennet*	Berne	F.
South Berne	Bailey, David*	Westerlo	F.
	Cattaraugus county		
Olean	Olean Bluestone Co.	Olean	B. S.
	Chenango county		
Oxford	Clarke Bluestone Co. F. G.	Oxford	
Tyner	Loomis, Perry*	Smithville	B. S.
	Delaware county		
Fish's Eddy	Martin, Geo	Hancock	
Hales Eddy	Kingsbury, O. M. & Co.*	Tompkins	B. S., F.
Hamden	Kenny, James*	Hamden	F.
Hancock	Cotter Bros.*	Hancock	
"	Kirkpatrick Bros	"	
Long Eddy	Kenny Bros	"	
" "	Peak, Cyrus*	"	F.
Lordville	Curry, John	"	
Peakville	Merritt, Geo. W.*	"	B. S., F.
"	Staib, J. J.	"	
Rock Rift	Huntington, E	Tompkins	
Stockport Station	Morse, J & Co	Hancock	
Walton	Gray & Marvin†	Walton	
"	St John, H. E.*	"	
"	Warner, G. T.*	"	B. S., F.

* PRODUCERS OF BLUESTONE — *concluded*

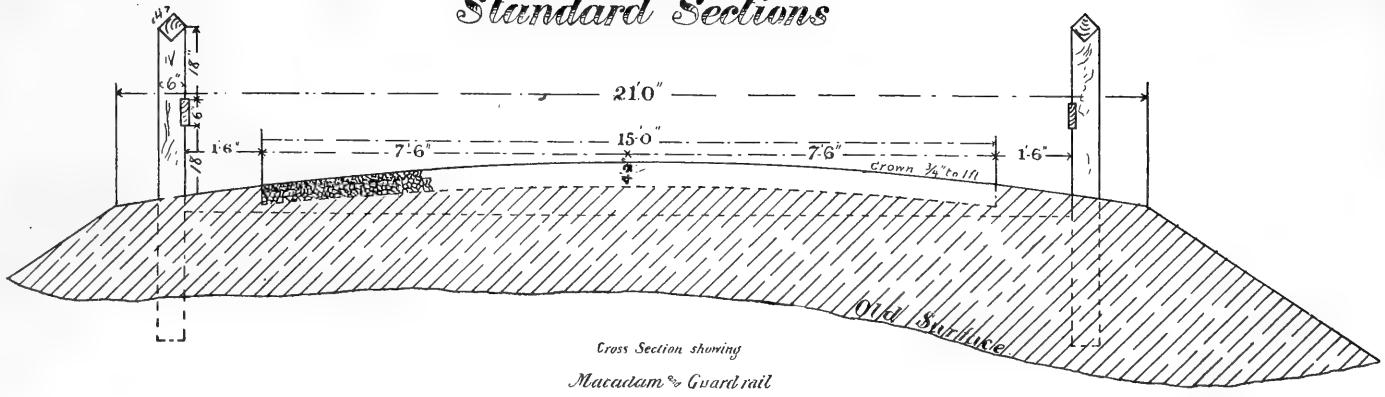
POST OFFICE ADDRESS	NAME.	Town or village nearest to the quarry	
Greene county			
Palenville	Lamouree, F. & Co.*	Catskill	F.
"	Newkirk, Isaac*	"	
Sullivan county			
Callicoon	Persbacker Bro's & Co.*	Callicoon	B. S., F.
Callicoon Depot	Dering, John	"	
Hankins	Manny, Anthony*	Fremont	B. S., F.
Long Eddy	Dunn & Co	"	
Narrowsburg	Engelman, Geo. W	Tusten	
Roscoe	Gregg & Miller	Rockland	
Ulster county			
Allaben	McGregor, S	Shandaken	
Brodhead	Hungerford, Alonzo	Olive	
"	Lyons L	"	
Glenford	Burton, H	"	
"	Krom, Wm	"	
Hurley	Ostrander, Samuel	Hurley	
Kingston	Roger & Tappan, dealers only		
Lomontville	Dunn, Patrick	Marbletown	
"	Rose, Andrew	"	
Malden	Ulster Bluestone Co.*	Quarryville	B. S., F.
Marbletown	Clearwater, Jacob	Marbletown	
"	De Graff, Wm	"	
Olive	Bogart, E. H.†	Olive	F.
Olive Bridge	Gemmell, James B.	"	F.
Phœnicia	Simpson, A. J	Phœnicia	
Plattekill	Longendyke & Co	Plattekill	
"	Sheffell, F. & Co	"	
Quarryville	Carnwright, Alphonso	Saugerties	
"	Fitzpatrick, Daniel	"	
Rondout	Boice, Hewitt, dealer only		
Sawkill	Peppard, Michael*	Kingston	B. S.
"	Walsh, Wm. & Sons*	"	B. S.
Stone Ridge	Turner, C. C.*	Marbletown	
Stony Hollow	Cassidy, Owen	Kingston	
"	Murtha, Michael	"	
West Hurley	Connors, Thomas*	Hurley	
West Saugerties	Carn, J. & Sons	Saugerties	
West Shokan	Boice, Lemuel	Olive	
Wilbur	Osterhoudt, Julius*	Kingston	B. S., F.
Woodstock	Lasher, D.*	Woodstock	F.
Wyoming county			
Portageville	Warsaw Bluestone Co	Gainesville	B. S.
"	Genesee Valley Bluestone Co.	Genesee Falls	B. S.

* For a complete list of all persons engaged in quarrying bluestone see Bulletin No. 15, New York State Museum.

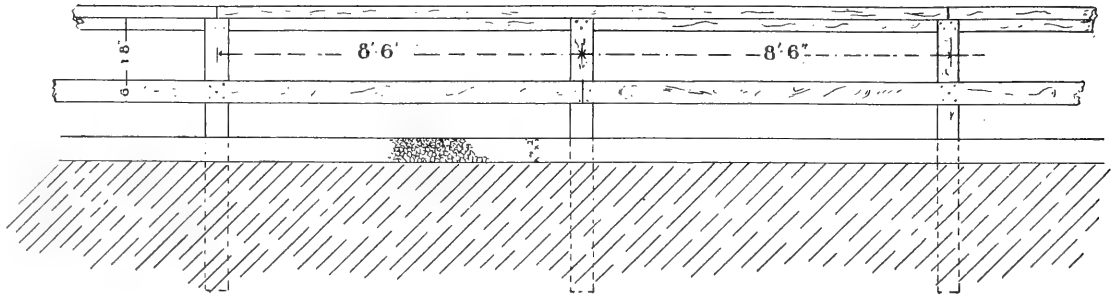
The foregoing directory of quarries and quarrymen, while probably not complete is very nearly so. As already indicated in the chapter on road materials, only a part of the quarries yield stone which is entirely satisfactory for road building. The reports of the Massachusetts Highway Commission, however, show that where the best material is not obtainable, other material can be put to a very good use, and a sandstone may make a very satisfactory foundation, when covered with trap or even with limestone, if nothing more desirable is available. Roads built in this way probably require more engineering skill in their construction and more careful watching in maintenance and repair. The local problems must be worked out in the future by actual experiment under the supervision of competent road engineers.

PLATE I.

Standard Sections



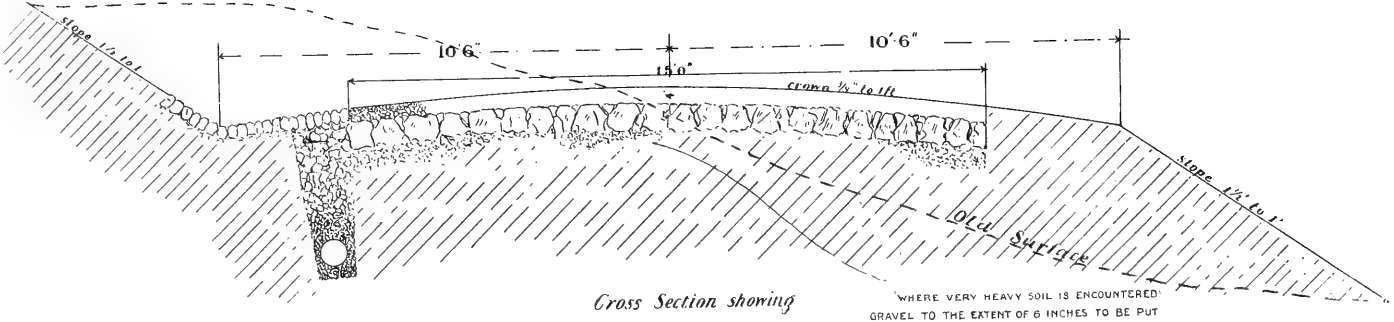
Cross Section showing
Macadam & Guard rail



Longitudinal section thro centre showing Macadam & rail

MASSACHUSETTS HIGHWAYS.

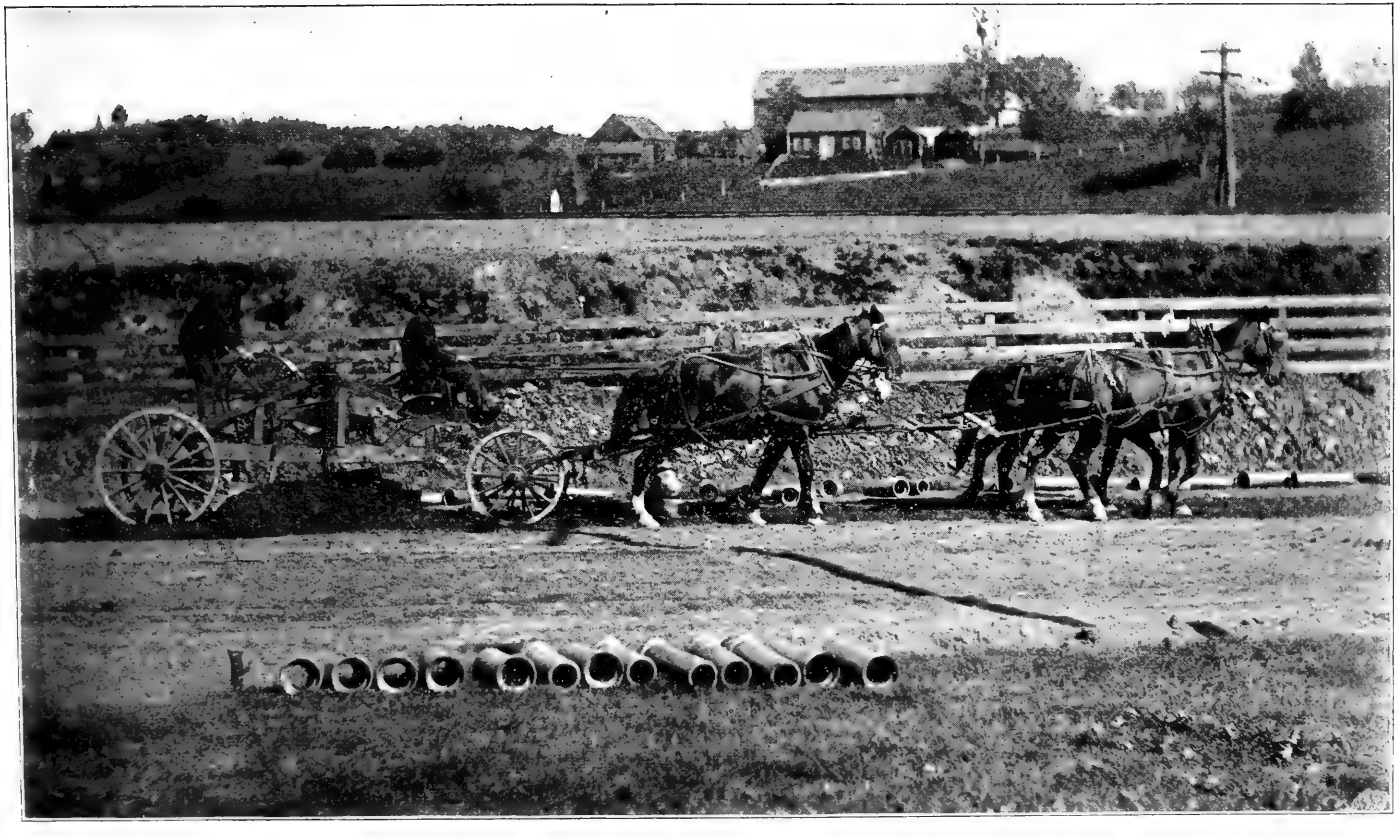
PLATE II



Cross Section showing
Drain, Macadam. Telford & Gutter
MASSACHUSETTS HIGHWAYS.

WHERE VERY HEAVY SOIL IS ENCOUNTERED GRAVEL TO THE EXTENT OF 6 INCHES TO BE PUT UNDER TELFORD.

PLATE III.

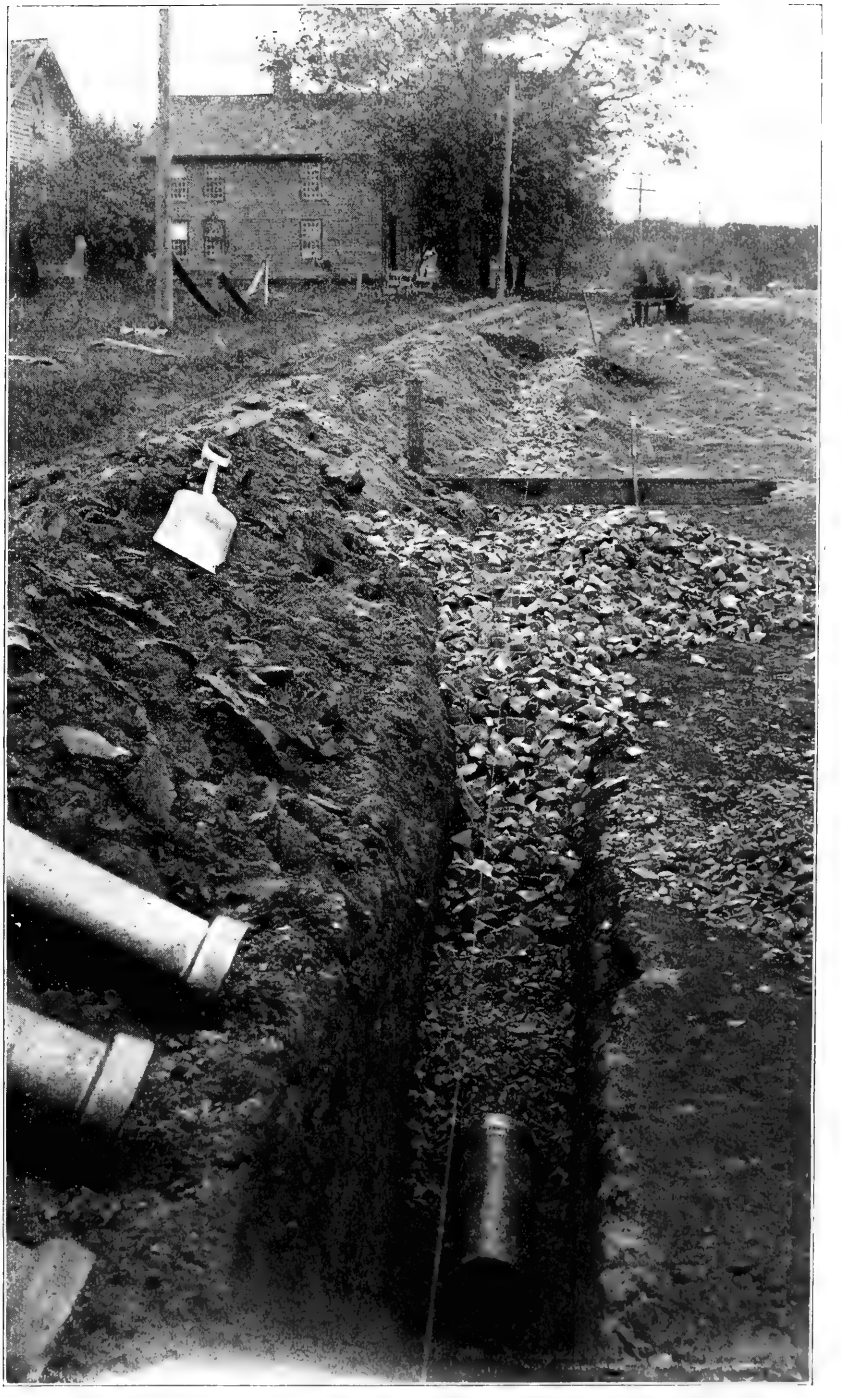


WESTFIELD ROAD, MASS., 1894.
View showing the road machine at work grading the sub-grade.

PLATE IV.

WESTFIELD ROAD, MASS., 1894.
View showing the method of constructing a drain in clay or other wet soil.

PLATE V.



WESTFIELD ROAD, MASS., 1894.
View showing details of drain.

PLATE VI.

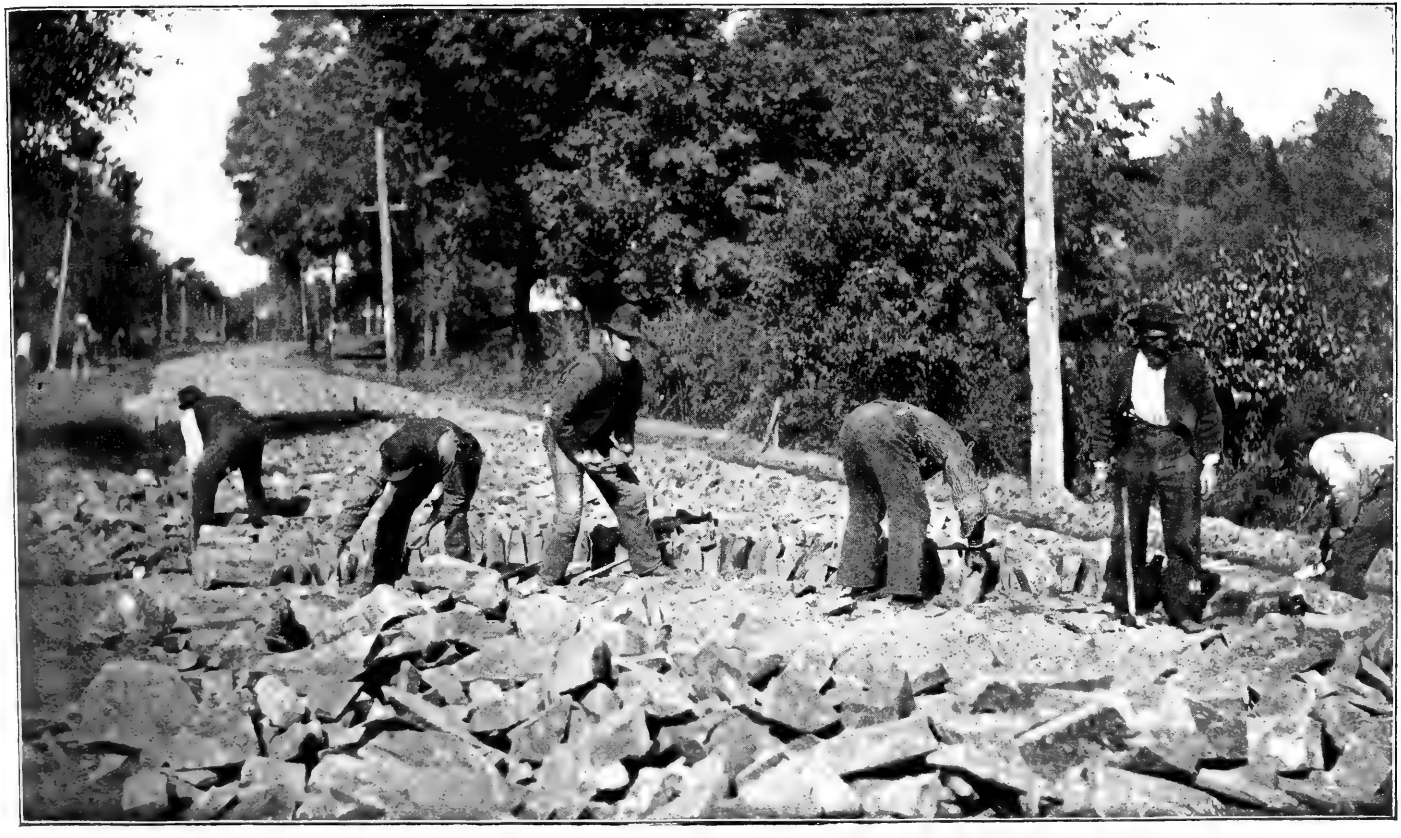
WESTFIELD ROAD, MASS., 1894.
View showing sub-grade graded and rolled, also the broken stone in place.

PLATE VII.

WESTFIELD ROAD, MASS., 1894.

View showing sub-grade graded and rolled, also the broken stone being put in place and steam roller at work

PLATE VIII.



WESTFIELD ROAD, MASS., 1894.
View showing method of laying Telford foundation on a gravel bed.

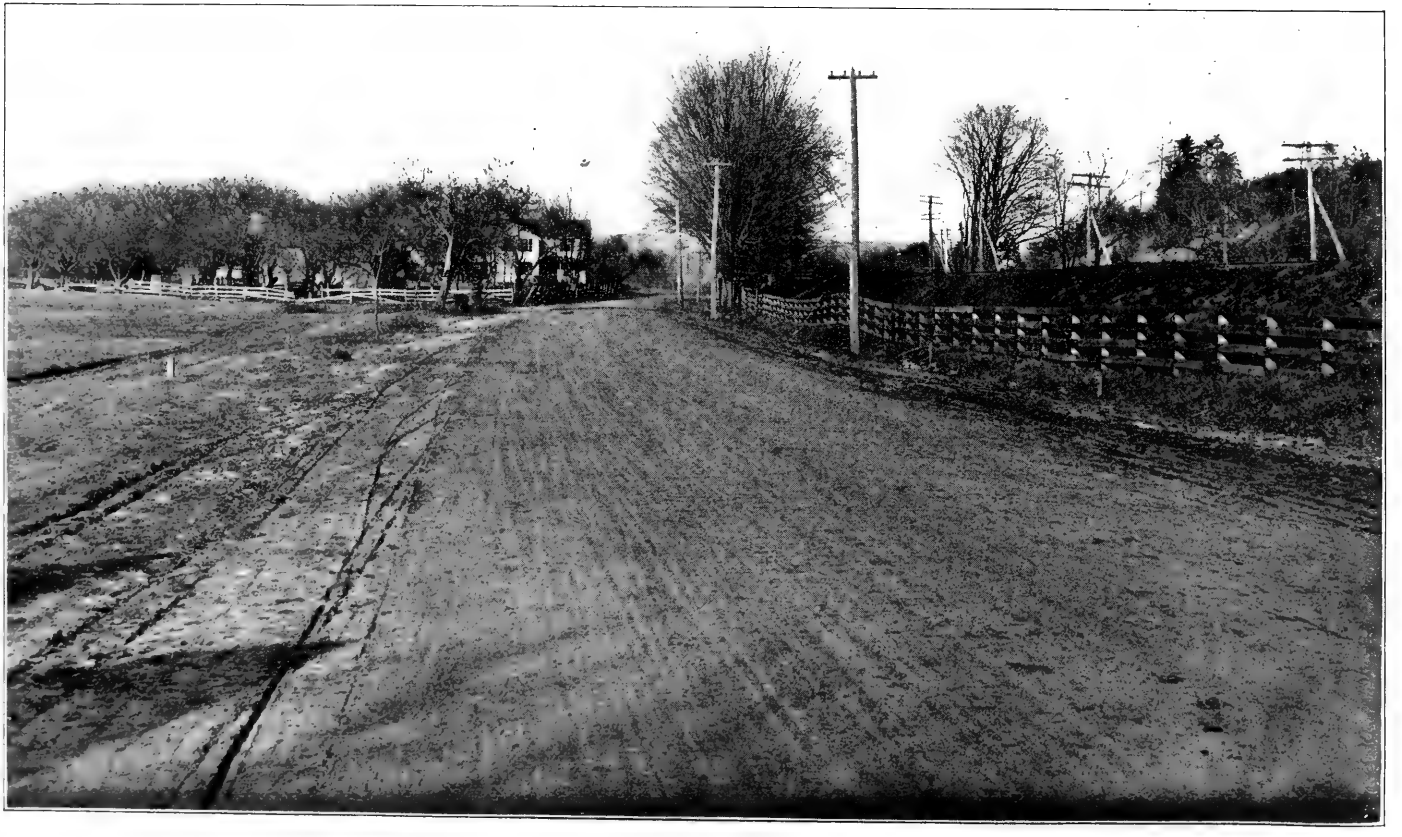
PLATE IX.

WESTFIELD ROAD, MASS., 1894.
View showing Telford road in process of construction

PLATE X.

Westfield Road, Mass., 1894.
View showing the finished roadway, together with steam roller at work.

PLATE XI.



WESTFIELD ROAD, MASS, 1894.
View showing completed road.

PLATE XII.

WESTFIELD ROAD, MASS., 1894.
View showing completed road.

PLATE XIII.

WESTFIELD ROAD, MASS., 1894.
View showing completed road with guard-rail.

PLATE XIV

WESTFIELD ROAD, MASS., 1894.
View showing completed road with bridge and guard rail.

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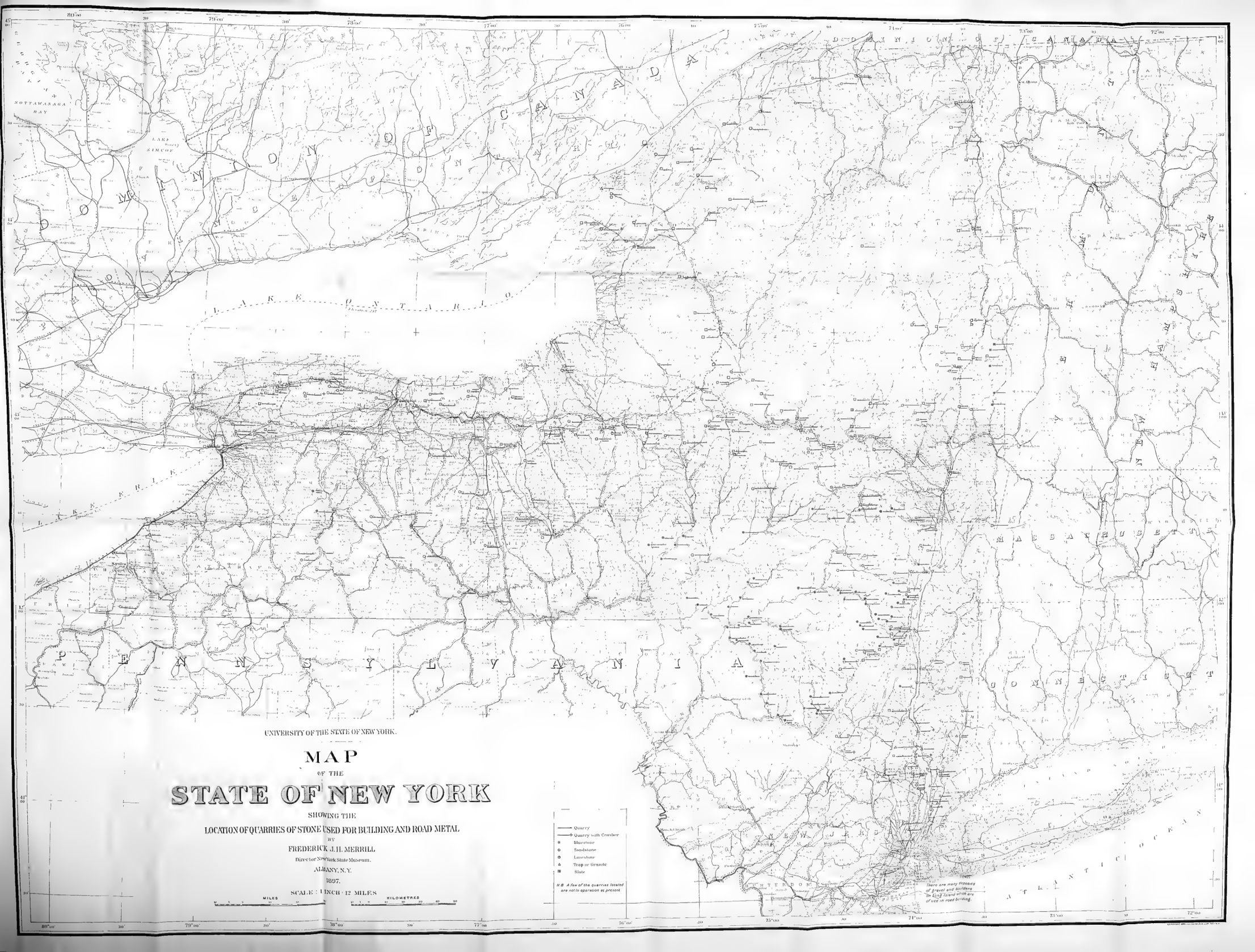
The superior figure points to the exact place on the page in ninths; e. g. 93^{7} means seven ninths of the way down page 93.


UNIVERSITY OF THE STATE OF NEW YORK.
MAP
OF THE
STATE OF NEW YORK
SHOWING THE
LOCATION OF QUARRIES OF STONE USED FOR BUILDING AND ROAD METAL
BY
FREDERICK J. H. MERRILL
Director New York State Museum.
ALBANY, N.Y.
1897.
SCALE 1 INCH = 12 MILES
MILES
KILOMETRES
Quarry
Quarry with Crusher
Bluestone
Sandstone
Limestone
Trap or Granite
Slate
N.B. A few of the quarries located are not in operation at present.
There are many deposits of gravel and boulders on Long Island which are of use in road building.
LAKE ONTARIO
LAKE ERIE
PENNSYLVANIA
MASSACHUSETTS
CONNECTICUT
NEW JERSEY
ATLANTIC OCEAN
CANADA

New York State Museum

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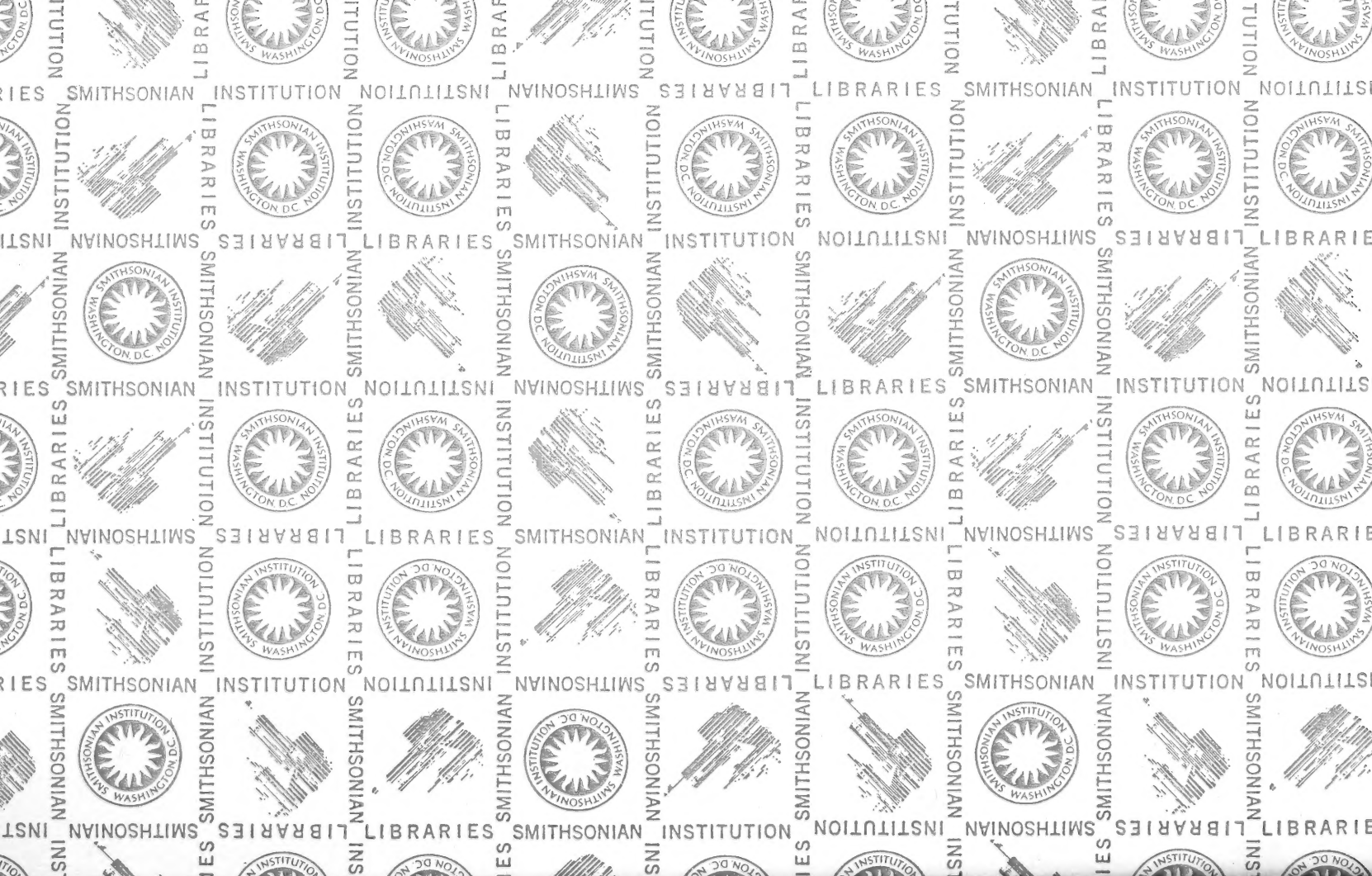
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